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New Zealand Orthopaedic Association
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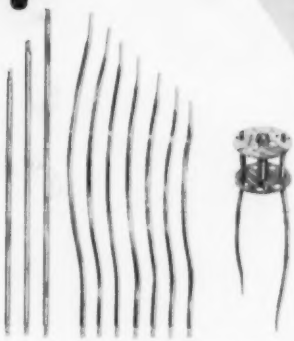

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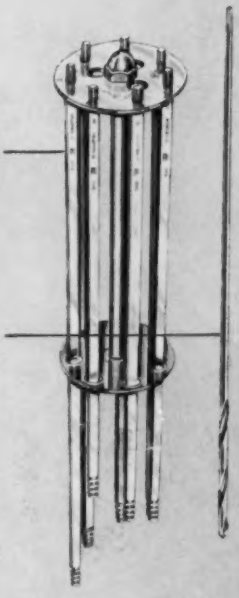

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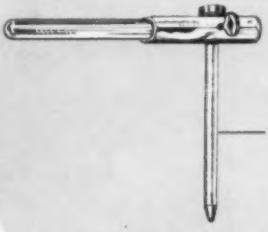

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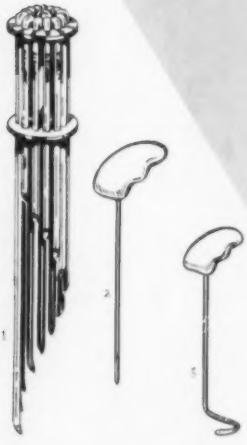

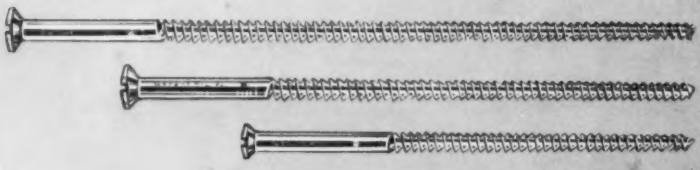

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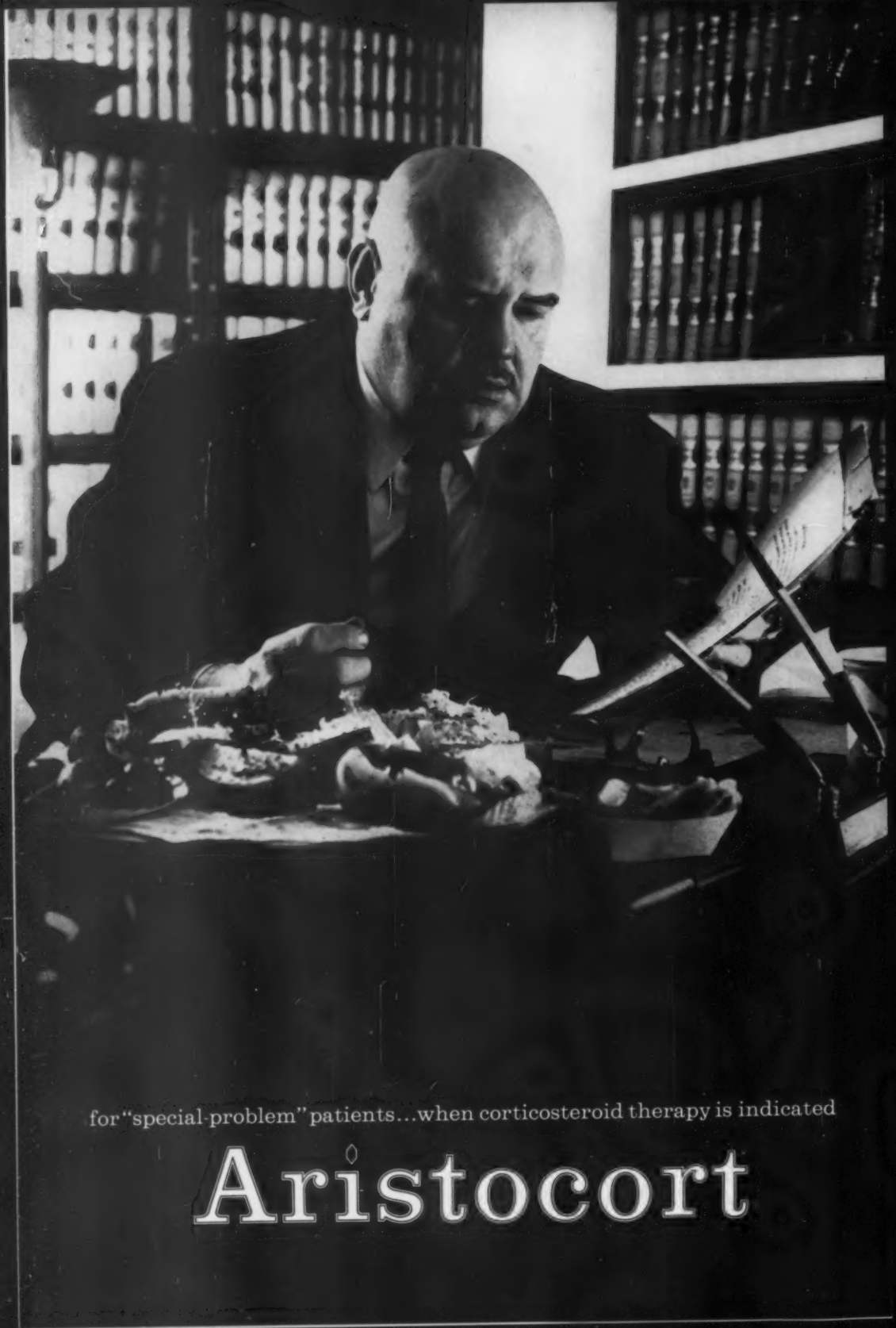

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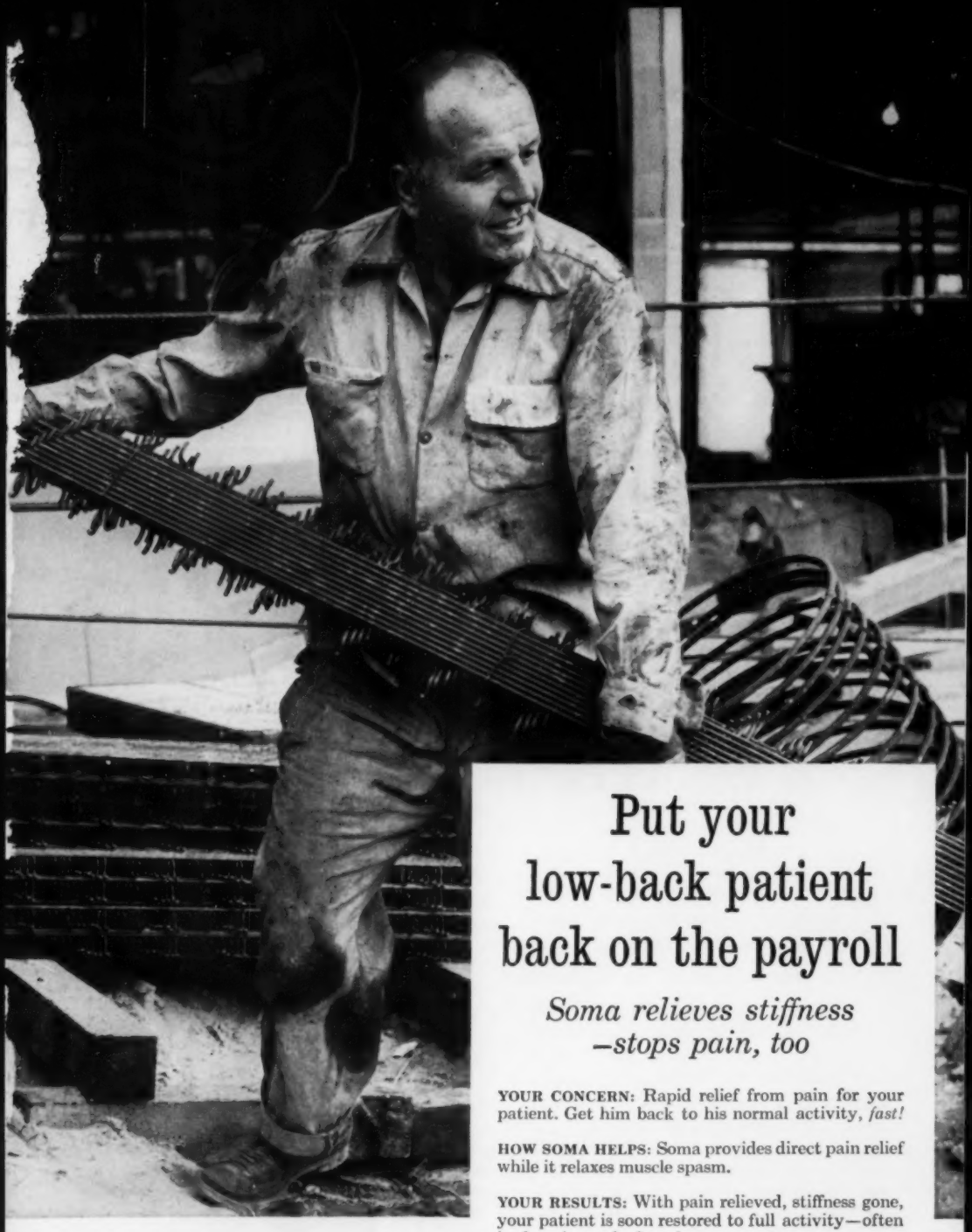

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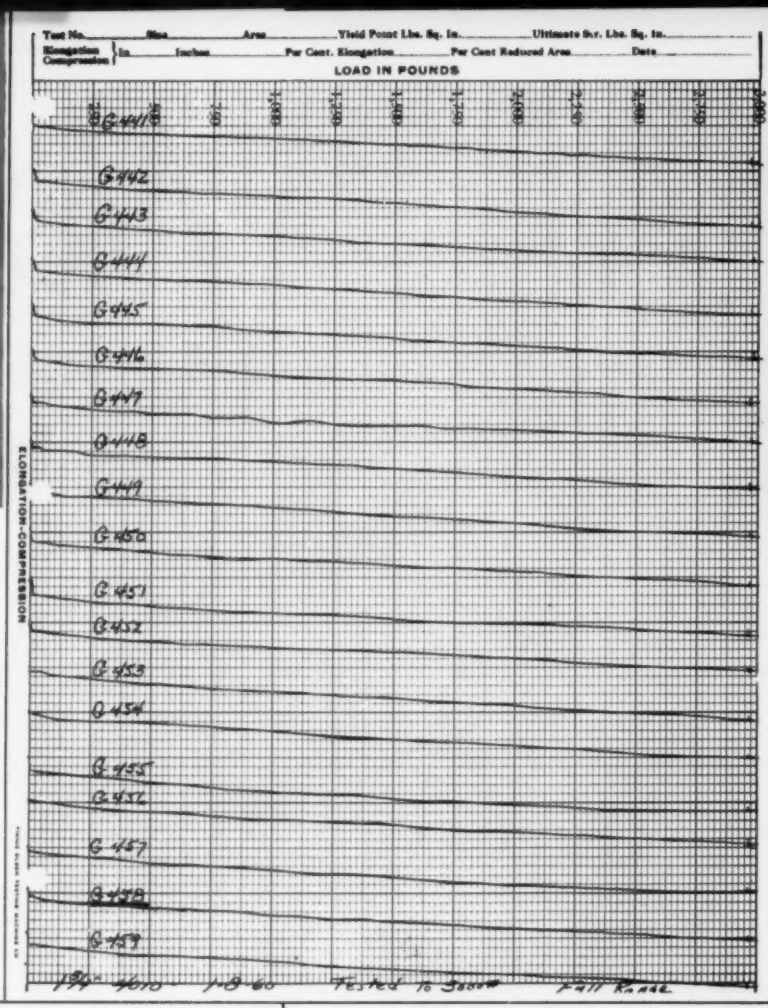
1. Each casting is X-rayed for internal soundness.
2. A notarized Material Certification is furnished by supplier. This certification which covers the chemical and mechanical test results of the metal, also certifies 100% X-ray and Zyglo Pentrex testing.
3. Each Zimaloy prosthesis undergoes a Non-destructive Mechanical Test. The Thompson Type is subjected to a standard direct load of 3,000 lbs. This standard load is safely below the elastic limits and does not weaken a sound prosthesis. If the prosthesis is unable to withstand this load a downward curve will develop on the chart which will indicate a weakness or defect.
4. A Zyglo bath is performed to detect surface flaws or defects not visible to the eye.
5. Each head is gaged for correct diameter.
6. Each prosthesis is visually inspected before being approved and sent to the stock room.

Certified Permanent Record:

Each Thompson Type prosthesis is etched with a permanent serial number which appears on its X-ray, the Material Certification, the mechanical test graph, and the final inspection report. There is a permanent record kept of each prosthesis which contains the certifications listed above. At any time in the near or distant future this record can be produced showing the date that the prosthesis was manufactured, the X-ray and all of the other certifications of its satisfactory quality. This is truly a prosthesis with a pedigree, another Zimmer first.



ZIMMER MANUFACTURING COMPANY
Warsaw, Indiana, U.S.A.

MATERIAL CERTIFICATION

TO Zimmer Mfg. Co.
Warsaw, Indiana

DATE December 30, 1959

ATT

MATERIAL SPECIFICATION	CUSTOMER ORDER NO.	PART NO.	DATE SHIPPED	QUANTITY SHIPPED	PACKING SLIP NO.
Stellite	C6731	4010 1-3/4" Thompson type	12/30/59	20	3457-498-S

CHEMICAL ANALYSIS Serial No. G441 through G460

MASTER HEAT NO. A250 LOT NO. 1613

C	Si	Mn	P	S	Cr	Ni	Fe	Mo
.27	.51	.63	.010	.011	27.52	1.86	.52	6.53

TEST RESULTS

ULTIMATE STRENGTH PSI	YIELD STRENGTH PSI	% ELONGATION	% RED. OF AREA	HARDNESS
127,300	76,380	10.0	10.3	30.5

XRAY 100% MAGNAFLUX Not Required ZYGLO Fentrex 100%

Remarks: As Cast

Chicago Spectro Service Laboratory, Inc.

WE CERTIFY THAT THE PARTS CONTAINED IN THIS SHIPMENT HAVE BEEN FABRICATED TO CONFORM TO YOUR SPECIFICATION AS NOTED

Subscribed and sworn to before me this 30 day of December, 19 59

Wendell D. Hite
Notary Public

My commission expires Feb 4, 1961

By H. J. Sabelka
H. J. Sabelka, Chief Met.

No. 9841A

ZIMMER MANUFACTURING COMPANY
MATERIAL DISPOSITION AND INSPECTION REPORT

DATE:	PART NAME AND NUMBER	ENG. CHANGE
2-23-60	#4010 1-3/4" Thompson type Prostheses	
PUR. ORDER NO. C 6731		

VENDOR: Zimmer Mfg. Co., Warsaw, Indiana ADDRESS:

RECEIVING REPORT NO.	P.O. NO.	QUAN. RECEIVED	QUAN. INSPECTED	QUAN. DEFECTIVE
		20	20	None

20 pcs. of the following serial numbers have been delivered to the shipping department. All castings have passed mechanical test, radiographic, Zyglo, and visual examination. Certification of chemical analysis of material used is on file and conforms to engineering specifications.

G441 G442 G443 G444 G445 G446 G447 G448 G449 G450 G451 G452

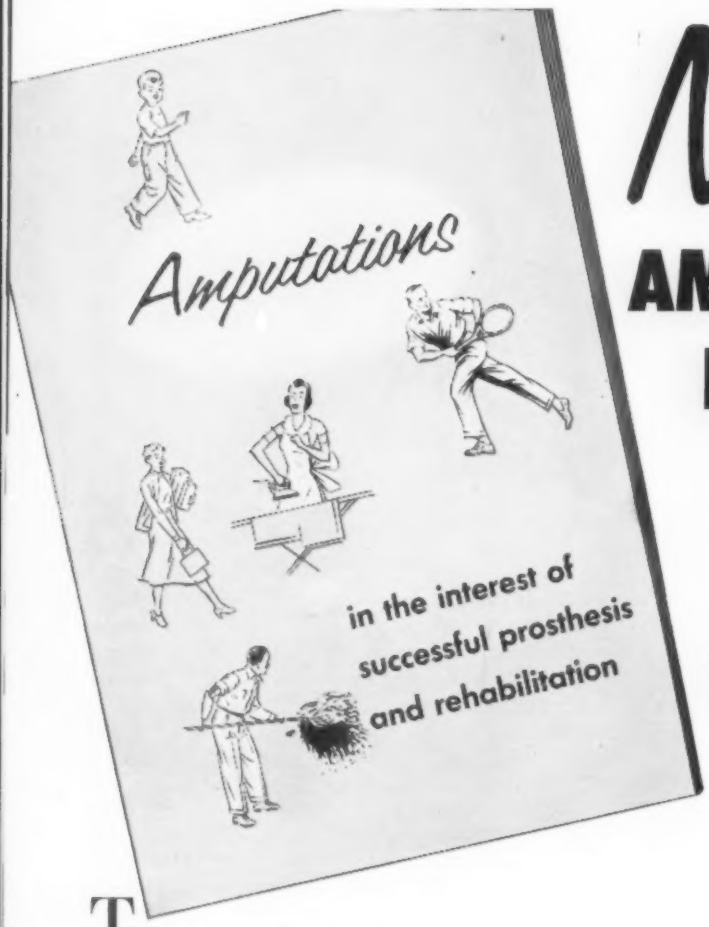
G453 G454 G455 G456 G457 G458 G459 G460

INSTRUCTIONS AND REMARKS:

DISPOSITION						APPROVAL		INSPECTOR
ACCEPT	REJECT	RETURN	SCRAP	MAT. REVIEW	SALVAGE	INSP.	ENG.	
20								

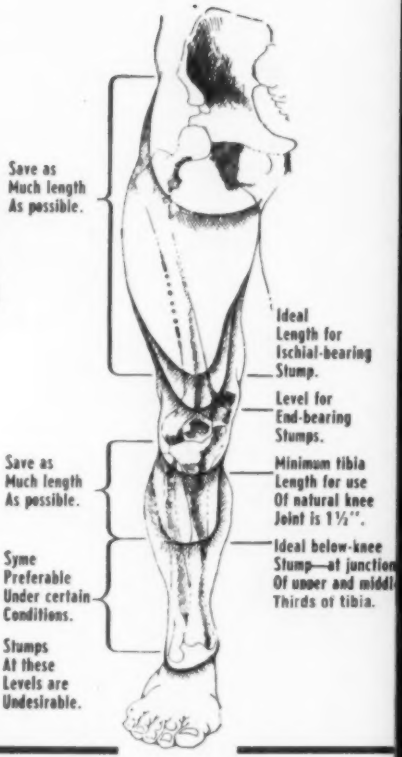
cc: MDIR
#4010

ZIMMER MFG. CO.
QUALITY CONTROL DEPT.



New AMPUTATION BOOKLET

THIS booklet, designed to serve as a concise reference regarding amputations, prostheses and the rehabilitation of the amputee, is now available. It has been written under the supervision of an eminent orthopedic surgeon and incorporates the experience gained by the Hanger organization from supplying prostheses for 100 years. Charts and drawings, showing the sites of election and various prostheses, and information about the care and fitting of the amputee, are presented. We believe you will find this booklet a valuable source of information. Write or phone the Hanger office nearest you for your Copy of the Amputations Booklet.


Save as Much length As possible.
Ideal Length for Ischial-bearing Stump.
Level for End-bearing Stumps.
Save as Much length As possible.
Minimum tibia Length for use Of natural knee Joint is 1½".
Ideal below-knee Stump—at junction Of upper and middl Thirds of tibia.
Syme Preferable Under certain Conditions.
Stumps At these Levels are Undesirable.

Hanger PROSTHETIC

AVAILABLE AT AUTHORIZED FACILITIES IN THE FOLLOWING CITIES:

Eastern Region:
BALTIMORE 1, MD.
BOSTON 15, MASS.
CHARLESTON 1, W. VA.
NEW YORK 11, N. Y.
PHILADELPHIA 7, PA.
RALEIGH, N. C.
RICHMOND 19, VA.
ROANOKE 12, VA.
WASHINGTON 13, D. C.

Central Region:
COLUMBUS 8, OHIO
PITTSBURGH 1, PA.

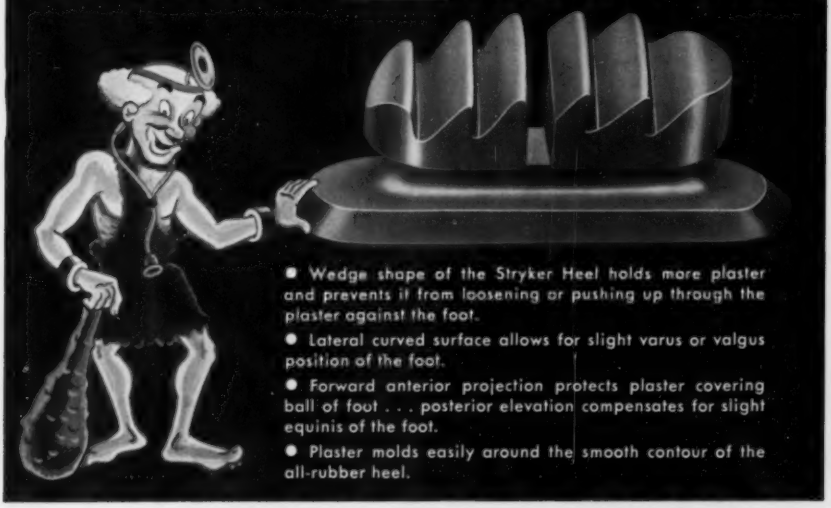
Southeastern Region:
ATLANTA 9, GA.
BIRMINGHAM 1, ALA.
COLUMBIA 1, S. C.
JACKSONVILLE, FLA.
LAFAYETTE, LA.
MIAMI 37, FLA.
MOBILE, ALA.
MONTGOMERY, ALA.
NASHVILLE 5, TENN.
NEW ORLEANS 19, LA.
ORLANDO, FLA.
SAVANNAH, GA.
ST. PETERSBURG, FLA.
TAMPA 2, FLA.
WEST PALM BEACH, FLA.

Midwestern Region:
CHICAGO 5, ILL.
CINCINNATI 29, OHIO
DALLAS 1, TEXAS
EVANSVILLE, IND.
FORT WAYNE, IND.
INDIANAPOLIS 2, IND.
OKLAHOMA CITY 3, OKLA.
PEORIA 4, ILL.
ST. LOUIS 66, MO.

NEW! *RIPPLE® HEEL for walking casts

A Stryker EXCLUSIVE!

DO YOU KNOW WHY THE STRYKER WALKING HEEL IS SUPERIOR?



- Wedge shape of the Stryker Heel holds more plaster and prevents it from loosening or pushing up through the plaster against the foot.
- Lateral curved surface allows for slight varus or valgus position of the foot.
- Forward anterior projection protects plaster covering ball of foot . . . posterior elevation compensates for slight equinis of the foot.
- Plaster molds easily around the smooth contour of the all-rubber heel.

Here's the finishing touch to the finest walking heel made.

The comfortable, cushioned action of the well-known patented RIPPLE® Sole used extensively for ordinary footwear, is preferred by all patients who have tried both types of walking heels during extensive comparison tests.

The RIPPLE® Sole principle absorbs walking shock, compresses when walking to convenient distance from floor, and provides better traction on slippery surfaces.

Per doz. $15.00

OFFICE MODEL **$24.50** Each

THE Stryker CAST SPREADER

The secret to the popularity of Stryker Cast Spreaders is in the *strong interdigitated teeth* that fit easily without wedging plaster into the slot made by the cast cutter.

A protective guard keeps the blade from advancing into the plaster and pinching the skin.

Set of 2 . . . $45.00

HEAVY DUTY MODEL Overall Height 19½" **$24.50** Each

Stryker

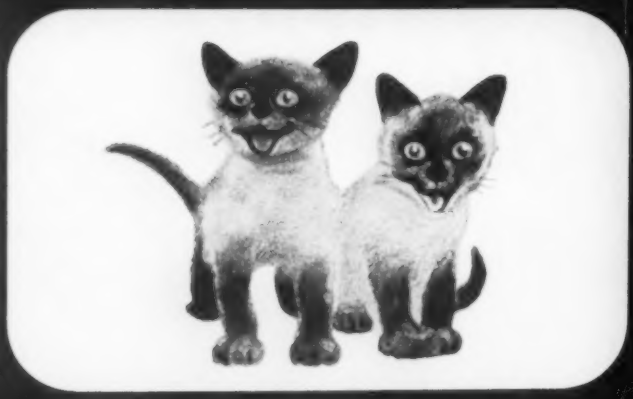
SURGICAL AND HOSPITAL EQUIPMENT

Orthopedic Frame Company

420 ALCOTT STREET • KALAMAZOO, MICHIGAN

* T. M. RIPPLE SOLE CORP.

In answering advertisements, please mention *The Journal of Bone and Joint Surgery.*



PERFECT MATES

When a child needs one shoe size for one foot and a different size for the other, Child Life Mismates are the "perfect mates" — for comfort, for style and for fit.

. . . And Herbst's Mismcte Service from stock means the end of six-weeks waits. When your prescription requires urgency Mismates will be shipped the same day the order is received — and they are sent Special Delivery.

Child Life
SHOES

MISMATE SERVICE

Write: Carlton Lincoln, HERBST SHOE MANUFACTURING CO.,
Box 2005, Milwaukee 1, Wisconsin

Richards

FEMORAL PROSTHESES

(SMo STAINLESS)

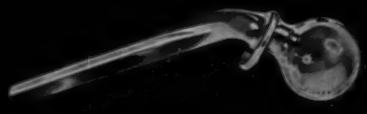
for every requirement

Richards Femoral Prostheses are solid forged, precision machined of SMo stainless, electropolished for optimum tissue tolerance. Offer maximum ductility, maximum strength, mirror finish and hollow concentric head for reduced weight. These popular forms available with specially designed rasps and broach to facilitate insertion. Teflon faced drivehead assures against damage to polished, precision head, producing smooth motion against the acetabulum, precludes possible contamination to surface of prosthesis head. Packaged in Kane Sterifabric Sterilizing Case.

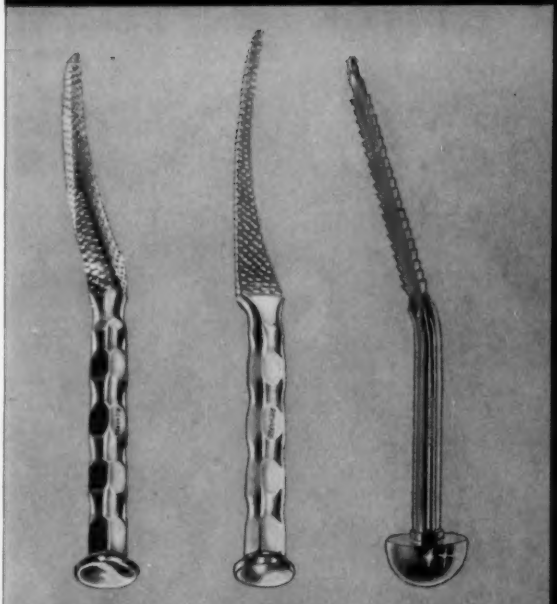
Write For Full Information

F. R. Thompson Type Hip Prosthesis — Popular choice of surgeons because of its ease of insertion and good results.

Moore Type Hip Prosthesis — Holes in stem allow bone growth through the prosthesis (sometimes filled with bone crumbs before insertion).



Eicher Type Hip Prosthesis — Tri-finned shaft, available in two diameters. Shaft length 5½"



Rasp for F. R. Thompson type prosthesis. **Rasp for Moore type prosthesis.** **Broach for Eicher type prosthesis.**

Teflon Faced Drivehead — Anodized aluminum body. Totally inert driving face of Teflon. Concave face fits all heads. May be autoclaved.

Richards

MANUFACTURING COMPANY

756 Madison Avenue, Memphis 3, Tenn.

3 vital considerations in relief of pain and restoration of function in hip pathology

Election of Arthroplasty

"Artificial prostheses for replacement of the upper end of the femur deserve a place in our armamentarium of treatment of hip disease."[1]

Choice of **Vitallium**®

"We believe that the cobalt-chrome alloys [VITALLIUM] have in clinical experience proved to be so superior in all respects to the existing stainless steels that they should now be very seriously considered for all surgical implants."[2]

Selection of Prosthesis

"... the Austin Moore intramedullary VITALLIUM prosthesis [is] one of the best prostheses available at the present time."[3]

Advantages of Hip Arthroplasty:

- Pain and disability relieved in most cases
- Shorter hospital stay; briefer convalescence period
- Less nursing care required
- Secondary surgical procedures unnecessary in virtually all cases
- Return to active, useful life

Indications for Hip Arthroplasty:

Osteoarthritis
Rheumatoid arthritis
Aseptic and avascular necrosis
Bilateral ankylosis
Salvage
Acute fractures in the aged
Un-united, long-term fractures
Delayed non-union
Acute unstable fracture (Pauwels' 3)
Pathologic fractures

For further information about VITALLIUM appliances, consult your surgical dealer or write to Austenal Company.

REFERENCES: 1. Gaenslen, F.G.: Wisconsin Med. J. 59:161, 1960. 2. Boyles, J. T., and Zarek, P.M.: J. Bone & Joint Surg. 37B:527, 1955. 3. Mansfield, F.: Rocky Mountain M.J. 55:47, 1958. 4. Callahan, J.J.: In Clin. Orth. North America. W.B. Saunders Co., Philadelphia, Feb., 1967, p. 135.

What is **Vitallium?**

VITALLIUM is a registered trade mark of the Austenal Company applied to certain cobalt-chromium alloys and to surgical appliances made from those alloys.

"[Its] unique suitability for surgical appliances derives from its inherent corrosive resistance, its compatibility with human tissues, its inertness and lack of electrolytic activity, together with its toughness and strength."[3]

Due to the toughness of the alloys, VITALLIUM appliances are not readily machined or formed by conventional methods. Special equipment designed by Austenal is used, thereby maintaining rigid specifications in all manufacturing procedures.

Twenty-five years of experience in machining and casting of VITALLIUM permits the accurate fabrication of many intricate designs necessary to conform to the anatomical requirements of the human skeletal structure.

Constant evaluation of raw materials, processes utilized, metallurgical knowledge and rigid inspection procedures insure the highest quality control standards for surgeon-approved VITALLIUM products.

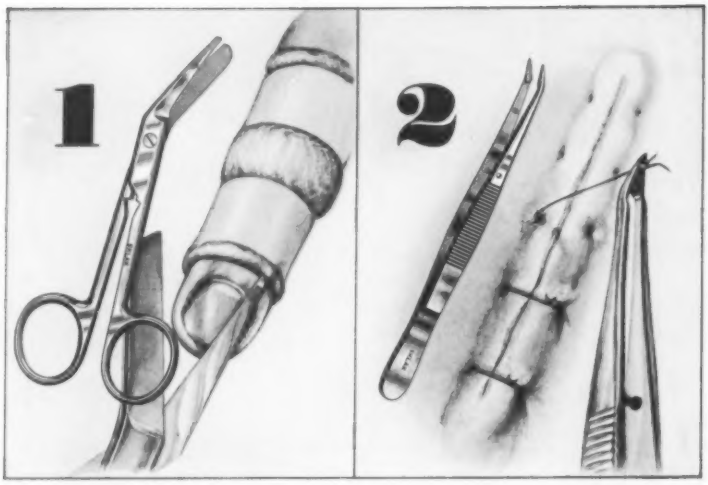
With over 9 million VITALLIUM surgical implants in use, not a single case of corrosion has been reported in the literature.

VITALLIUM®

Pioneer and leader in corrosion-resistant surgical alloys

AUSTENAL COMPANY SURGICAL PRODUCTS

Division of Howe Sound Company



specifically designed for the purpose

1 Burnham Finger Bandage Scissors

Minimizes pain caused by conventional acorn tip ...thin lower blade with rounded tip slips easily under bandage... notched shank facilitates ready removal of needles frozen to syringes...provides leverage to shear through heavy dressings — yet compact and light enough for the pocket.

Healy Suture Removing Forceps 2

Superior to anatomic forceps for suture removal... broad triangular shaped jaws... roughened inner surfaces grip and hold the suture for cutting...precisely aligned, pointed tips permit gentle teasing out of suture ends that have retracted under the skin or become encrusted with exudate.

SKLAR PRODUCTS

Both instruments precision made of stainless steel by SKLAR, Long Island City, N.Y.
Available through accredited surgical supply dealers.

Parents can afford
CHESBROUGH
Orthopedic Pre-Walkers

No. 1400 OPEN TOE
Straight-line symmetrical last, firm heel, no back seam. Adaptable to Denis Browne Splints.

No. 1300 CLOSED TOE
Lace-to-toe design permits snug, gentle fit. Perfectly smooth inside.

No. 1700 CLUBFOOT, OPEN TOE
Special outflare last, sturdy instep strap to stabilize heel.

Louis C. Weld, President of G. W. Chesbrough Co. . . . "My own personal experience led to the development of the new Chesbrough Shoe."

Here are Orthopedic infants' shoes that meet rigid requirements of corrective footwear yet fit the family budget.

High-quality workmanship and fine leathers with orthopedically correct lasts are combined in Chesbrough Shoes to sell at a moderate price.

Any parent whose child requires orthopedic correction knows the expense is great, as frequent purchase of new shoes is required.

This problem was brought home to Chesbrough's president, Louis C. Weld, three years ago, when a child in his own family needed such a shoe. Recognizing the need for orthopedic shoes at an economical price, Chesbrough Company put their 60 years of shoemaking experience to work and Chesbrough Corrective Pre-Walker Shoes were born.

All shoes in unlined white elk, sizes 000 to 4, narrow and wide. Available in full pairs, split pairs or single shoes (no extra charge for half pairs).

MAIL COUPON FOR FREE DESK SAMPLES

G. W. CHESBROUGH CO.
807 Smith Street, Rochester 6, N. Y.

NAME.....

ADDRESS.....

CITY..... STATE.....

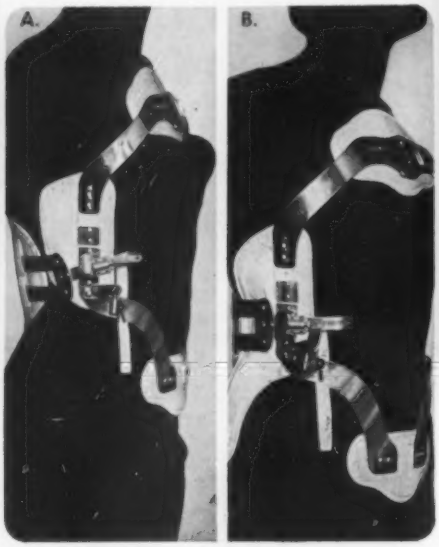
YOUR ORTHOPEDIC SHOE DEALER:

.....

THE JEWETT HYPEREXTENSION BACK BRACE*

FOR

1. Uncomplicated Compression Fractures and/or Kummell's Disease
2. Osteoporosis, with or without compression fractures
3. Marie Strumpell's Arthritis of the spine
4. Adolescent Epiphysitis (Scheurmann's Disease)



A. Standard Hyperextension Model
B. The Post Lumbo-Sacral Fusion Model

RIGID — ADJUSTABLE — LIGHT WEIGHT — WASHABLE

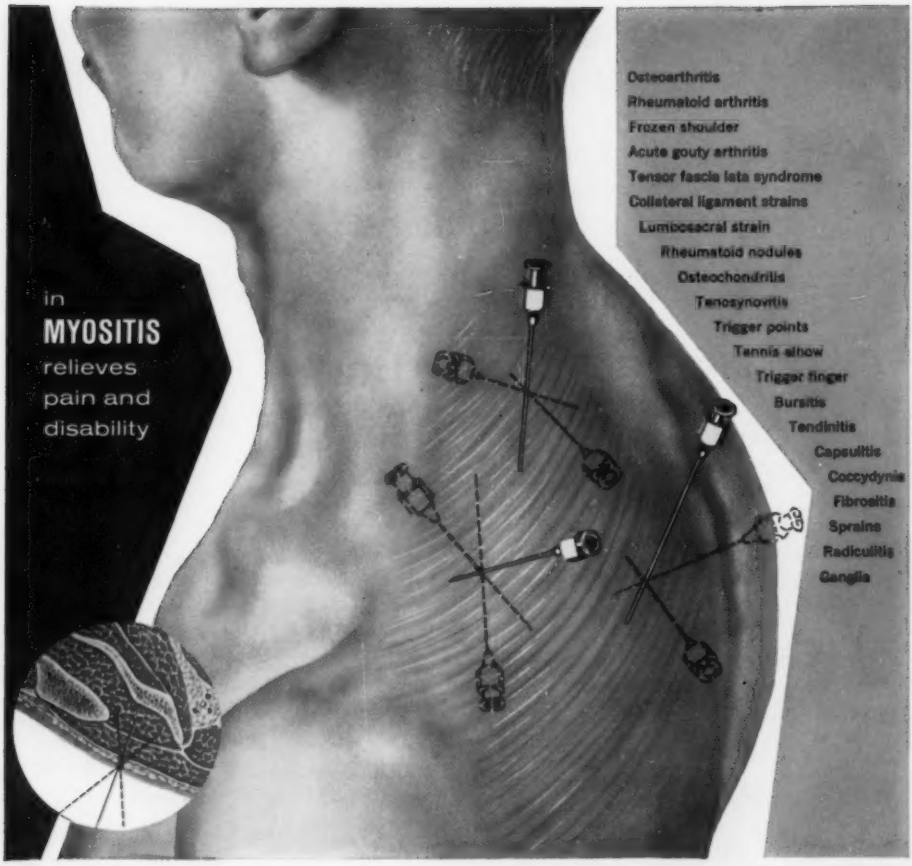
You are also invited to inquire about:

- The EXTENSION-FLEXION Collar
- The MYO-VENT Collar
- The CER-VENT Collar (Extension & Flexion Models)
- The MYO-CERVICAL Collar

Catalogs, Reprints and Measuring Charts Upon Request

* FLORIDA BRACE CORP.

601 WEBSTER AVENUE «» POST OFFICE BOX 1366
WINTER PARK 3, FLORIDA, TELEPHONE MIdway 4-2650



SUSPENSION

HYDELTRA-T.B.A.®

PREDNISOLONE TERTIARY-BUTYLACETATE

CONSISTENTLY EFFECTIVE—PROLONGED RELIEF

Dosage: the usual intra-articular, intrabursal or soft tissue dose ranges from 20 to 30 mg. depending on location and extent of pathology.

Supplied: Suspension HYDELTRA-T.B.A.—20 mg./cc. of prednisolone tertiary-butylacetate in 5-cc. vials.

Additional information is available to physicians on request. HYDELTRA-T.B.A. is a trademark of Merck & Co., INC.

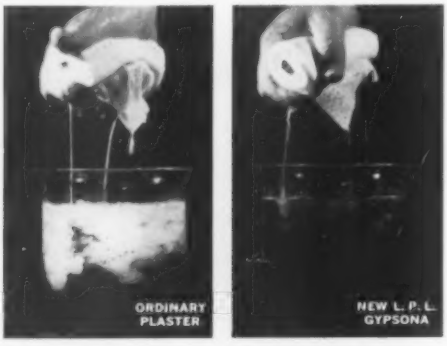
MSD MERCK SHARP & DOHME
Division of Merck & Co., Inc., West Point, Pa.

Now! Gypsona brings you a creamy plaster bandage that retains its full strength after dipping and squeezing

New L. P. L. Gypsona lets you mold strong, light, longer-wearing casts—with fewer bandages

Until now, a tariff was paid to the drain bucket. Needed plaster strength was sometimes squeezed out, washed away.

Now, however, with the perfection of L.P.L. (Low Plaster Loss) Gypsona, you can mold 96% of the plaster into the finished cast. Now, newly developed adhesive agents securely anchor the plaster to the base cloth.



The difference is immediately apparent

Here you see two bandages being subjected to approximately the same amount of pressure after dipping. The disparity between the ordinary bandage and L.P.L. Gypsona is clearly evident. The Gypsona drainage is almost clear water.

The implications are many

Most certainly, you will use fewer bandages—a cheery note for the keeper of the budget. There's less residue to contend with. You have cleaner handling throughout.

You also enjoy advantages that have long endowed the international prominence of Gypsona.

Creamy, conformable and tough

The deeply buried leno fabric molds firmly about bones, protuberances and indentations. The comfortable Gypsona creaminess, as always, is a pleasure to work with.

Now your most difficult plaster casts can be made with creamy smooth, extra strong L. P. L. Gypsona.

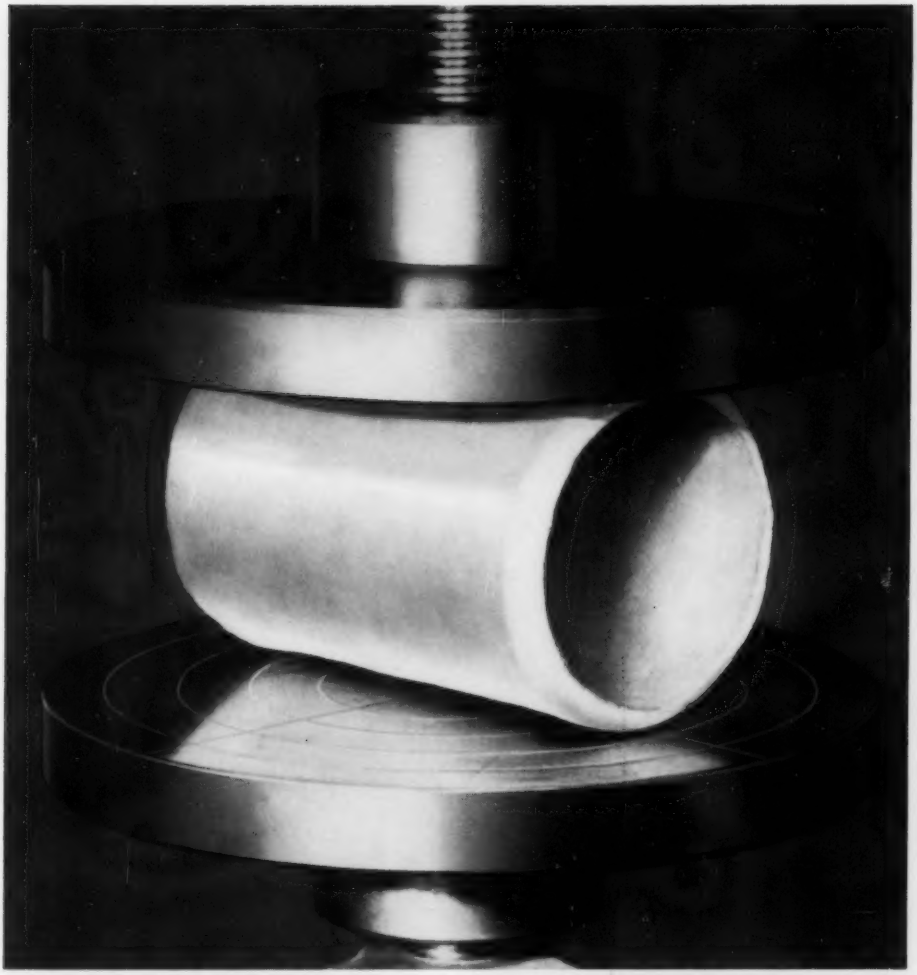
The threads do not slide. There is no sawtooth edge. The finished cast has the rich, polished glint that comes only of fine English-quarried plaster.

Price is still the same

Not to be overlooked is the ease of unwinding with the Gypsona plastic core, which prevents telescoping. Plaster stays fresh, almost indefinitely, in the airtight Gypsona package. And the price is still the same as standard Gypsona plaster bandages.

For a first-hand demonstration of L.P.L. Gypsona, get in touch with your Bauer & Black representative.

In answering advertisements, please mention *The Journal of Bone and Joint Surgery.*



In the course of precision testing, a single L.P.L. Gypsona bandage, 4 inches wide and 3 yards long, was molded into a standard cylinder. After 24 hours, the cast was submitted to the strength-measuring apparatus above. The cast endured 304 lbs. pressure before it was crushed beyond a functional shape.

Curity®

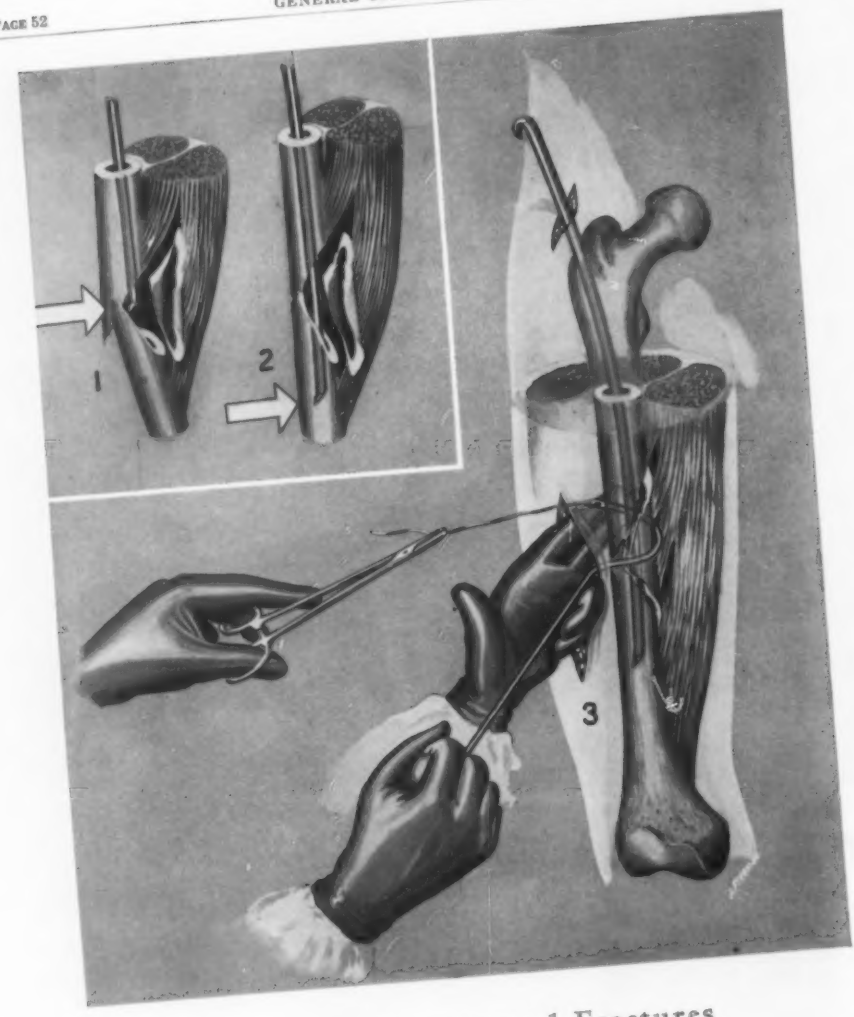
L.P.L. Gypsona*

PLASTER BANDAGES

THE KENDALL COMPANY

BAUER & BLACK DIVISION

*Reg. T. M. of T. J. Smith and Nephew Ltd.

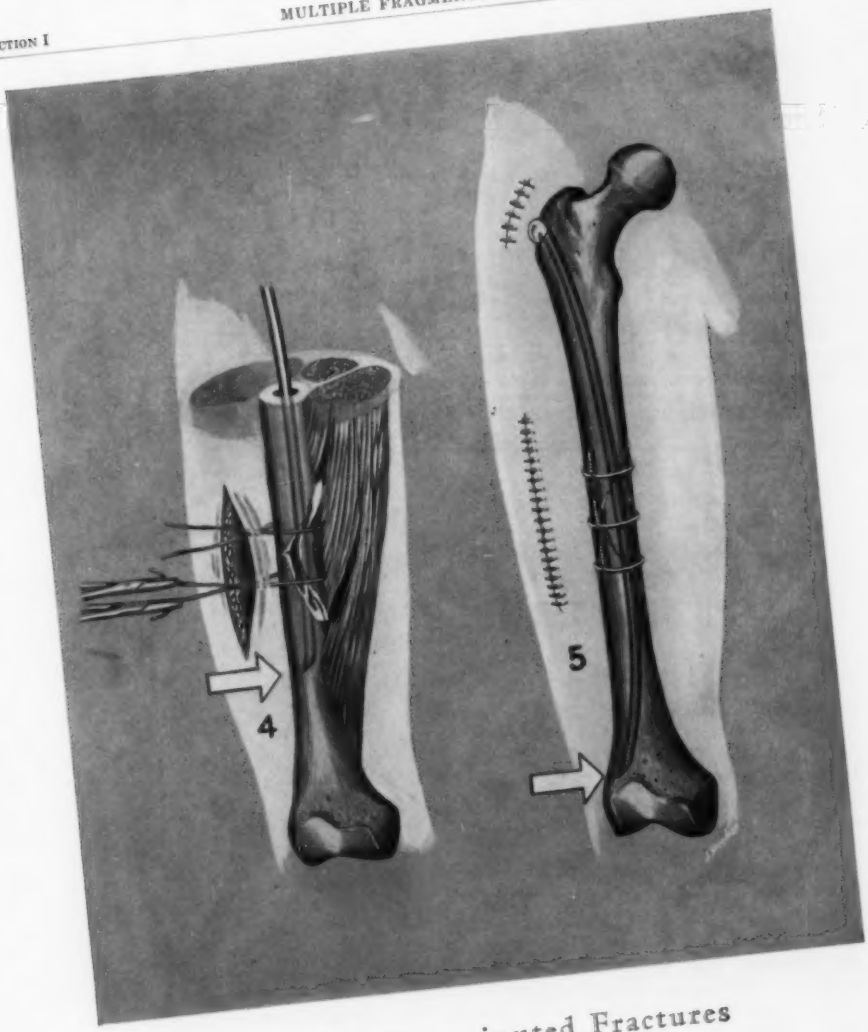


Technic Comminuted Fractures

(1) Drive the pin to fracture site.

(2) Align proximal and distal fragments, engage pin in distal fragment, but do not drive pin home.

(3) Leave soft tissue attached to fragments. Pass wire-carrier close to bone, through the muscle attachment using the guiding fingers. Thread point of wire carrier to place wire loop around the bone.



Technic Comminuted Fractures

(CONTINUED)

(4) Use wire loops instead of bone clamps to maneuver fragment or fragments into position. Twist wire snugly but not tight.

(5) Drive pin home, tighten wires to complete operation.

THE BERIVON Company
Meridian, Miss.
MANUFACTURERS RUSH PINS AND INSTRUMENTS • PUBLISHERS ATLAS OF RUSH PIN TECHNICS

Aireloom INVENTS A NEW MATTRESS THAT NEEDS NO BUILT-IN BEDBOARDS

VITAGENIC—the prescription-built extra-firm mattress eliminates the need for old-fashioned built-in bedboards. That's because VITAGENIC is made right! Many mattresses are structurally weak, basically inadequate and require the addition of a makeshift board to strengthen them. VITAGENIC stands alone as the first *true* therapeutic mattress for pain of backache or sacroiliac injury.

VITAGENIC—the prescription-built extra-firm mattress—*offers curled hair for resilient firmness!* Your patients get the benefit of firm body support without undue stress on nerve points or interference with circulation. VITAGENIC also guarantees *hand-stitched sidewalls that do not sag!* Your patients are able to get in and out of bed with less effort and greater stability because VITAGENIC's sag-free sidewalls allow no "give" that might upset your patient's equilibrium. This means *12% more usable sleeping surface* and is only achieved by meticulous hand-stitching.

VITAGENIC—the prescription-built extra-firm mattress, is a mattress and box spring combination made *exactly* to the specifications of registered orthopedic specialists. With VITAGENIC, there can be no doubt your patient is resting correctly and comfortably. *You* prescribe the optimum degree of firmness necessary as well as other features important for your patient's treatment.

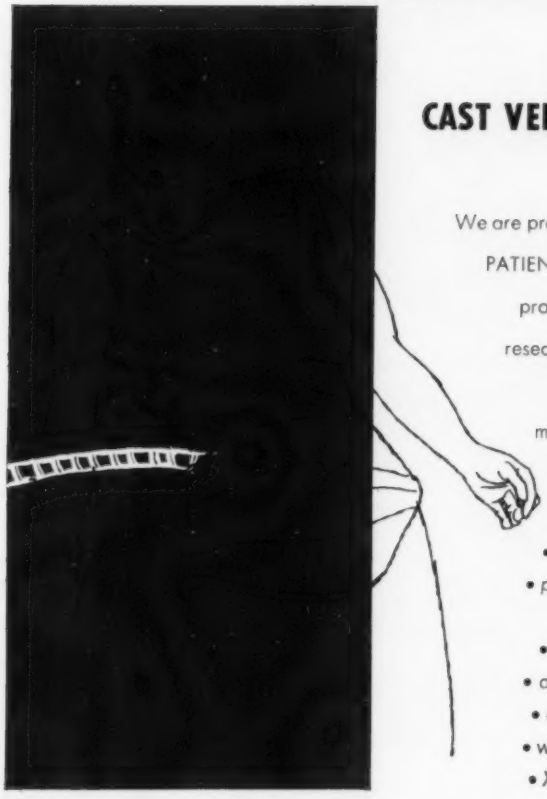
THE VITAGENIC IS GUARANTEED IN WRITING FOR FIFTEEN YEARS!

For full details on the extra-firm prescription-built VITAGENIC, contact

Aireloom **BEDDING COMPANY**

1119 Westminster Avenue, Alhambra, California
created by King Karpen — established 1951

PATIENT aire



for under
CAST VENTILATION

We are proud to introduce PATIENT-AIRE, another product of Conco's research into modern materials for modern medicine.

- *reduces itching*
- *prolongs cast life*
- *dries cast*
- *diminishes odor*
- *avoids ulceration*
- *cools under cast*
- *warms under cast*
- *X-ray permeable*

CONCO
SURGICAL PRODUCTS, INC.

RESEARCH • DEVELOPMENT • PRODUCTS
BRIDGEPORT • CONNECTICUT

Exclusive Preview*
Assures Effective Support Therapy

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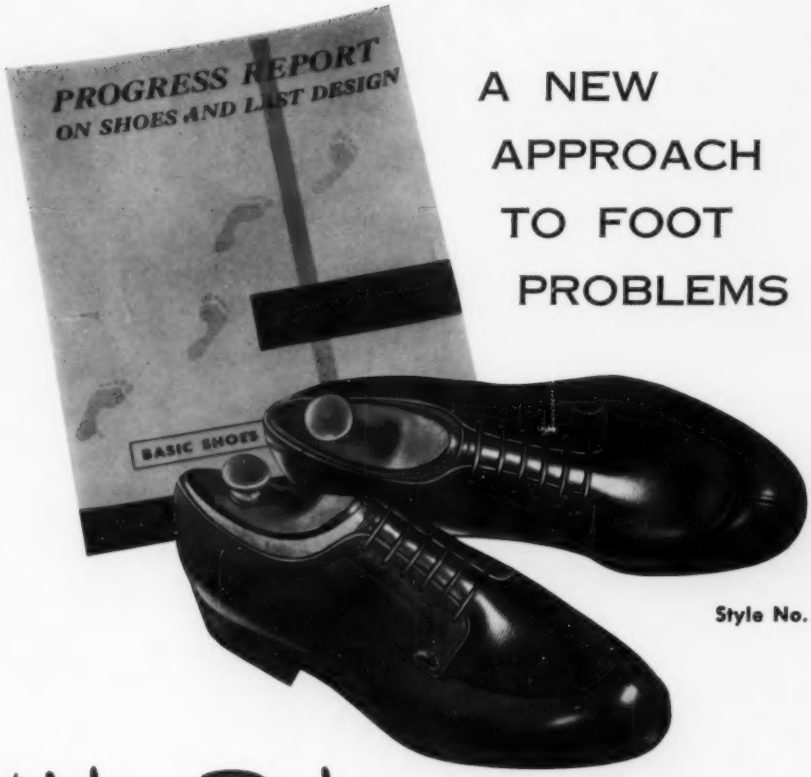

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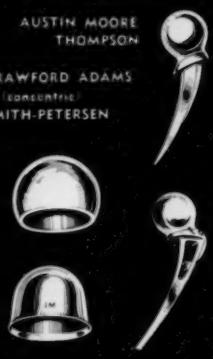

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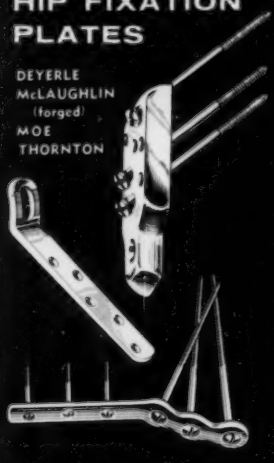

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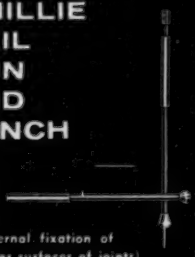

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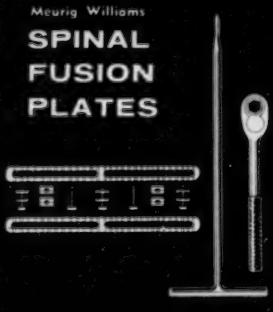

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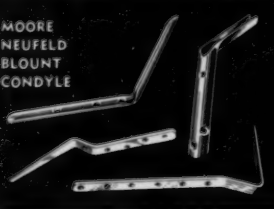

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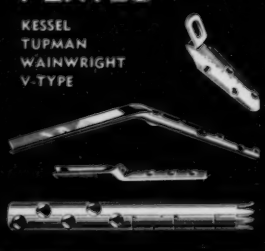

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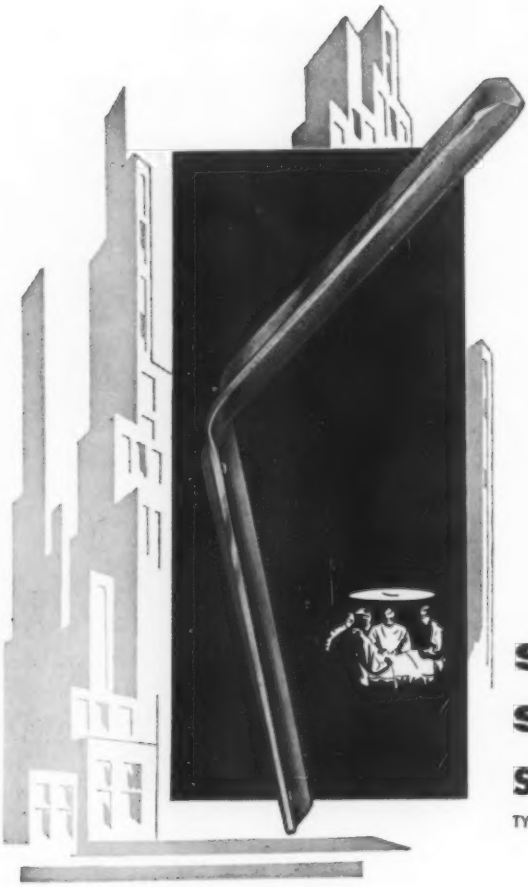

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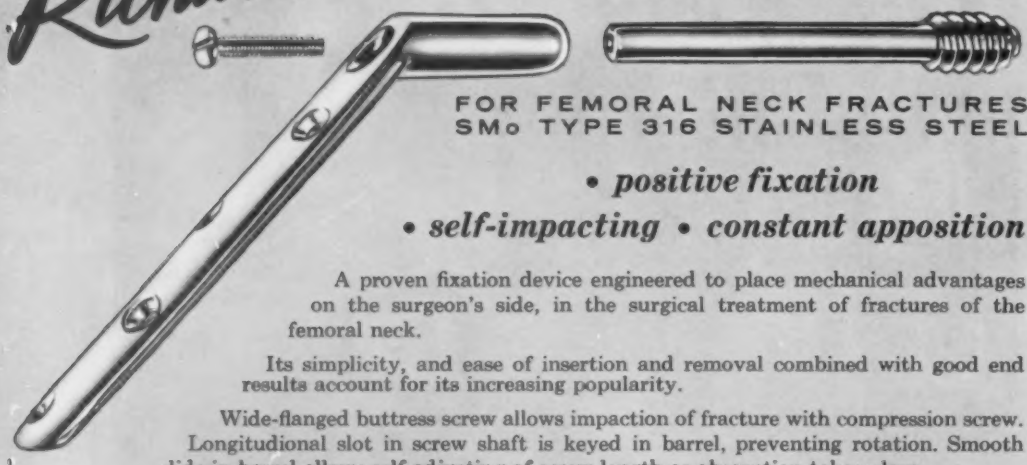

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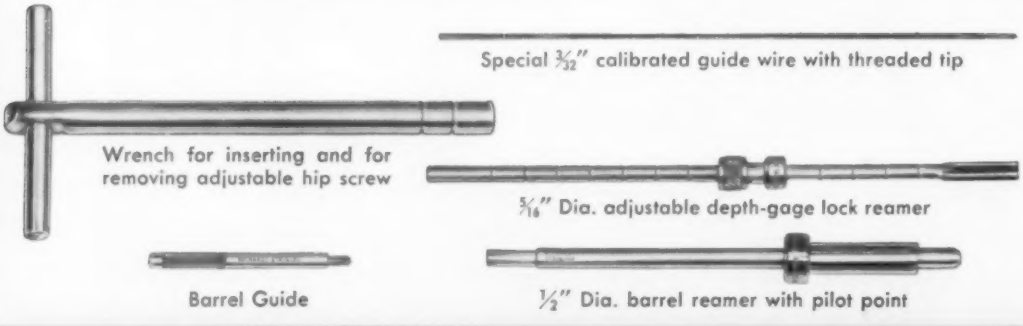

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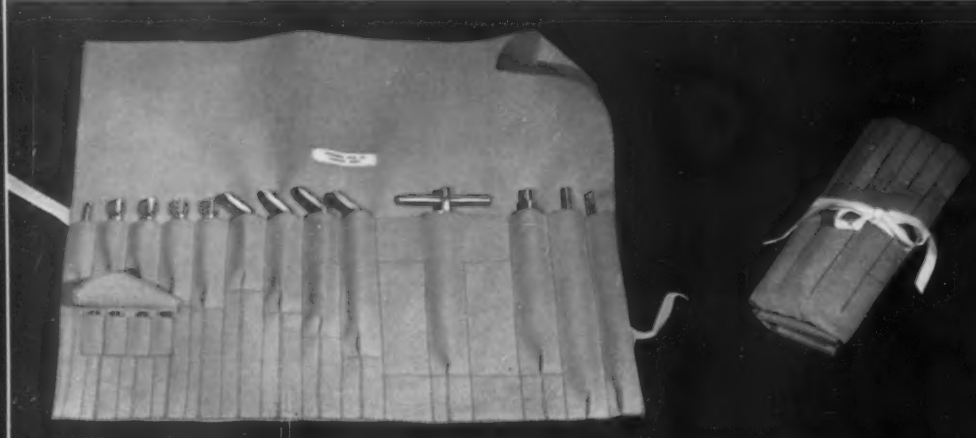

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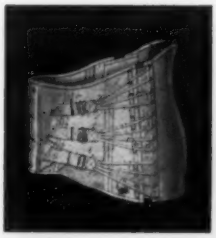

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Editorial

Changing Concepts of the Scoliosis Problem

Orthopaedists have for some time been aware of an upsurge of interest in scoliosis and its associated problems. The defeatest attitude toward correction and maintenance of correction of lateral curvatures reached a peak during the years from 1930 to 1950. Only recently have there been increasing signs that this attitude is being replaced by enthusiasm engendered by success.

Orthopaedic surgeons in many areas of the United States and in many other countries have in past years incorporated into their resident-training program so meager an exposure to scoliosis that orthopaedists are being sent out into practice each year without fundamental knowledge or any concept of what can be done for the child with lateral curvature of the spine. The minds of many have been closed to the unbiased evaluation of the efforts being made in scattered areas to teach basic principles of treatment of scoliosis and to demonstrate the really excellent results which are consistently obtained when these principles are intelligently applied.

Many of the benefits now being made available to the scoliotic child have materialized through advances in the fields of pulmonary physiology, surgical physiology, and anesthesia. Only thirty years ago, in a Midwestern children's orthopaedic hospital, an attempt to initiate a program of curve correction and fusion was abandoned because of the high mortality associated with spine fusion. Eighteen years later, with adequate skilled anesthesia and blood replacement, a similar program proved successful.

The multitude of problems associated with the varieties of scolioses encountered leaves the average orthopaedic surgeon confused and doubtful of the choice of treatment of the individual problem. He hopes for a solution easier than that supplied by extended study in a scoliosis center and he is inclined toward gadgetry, neglecting the treatment which time and experience have proved to be the most effective.

At the present time, as in years past, experienced orthopaedic surgeons are less concerned about methods of correction than they are with maintenance of the correction achieved. There appears to be little doubt that a posterior fusion of sufficient length and of unquestioned integrity is necessary for the maintenance of permanent correction of a structural curve. The methods of correction and the selection of the proper fusion area may be readily learned. More difficult to achieve is a sound arthrodesis.

From all available data, it would appear that fusion techniques which in-

clude destruction and bridging of the articular facets offer the greatest opportunity to procure a solid fusion. Likewise, there is much evidence to support the conviction that the addition of fresh autogenous bone enhances success of the arthrodesis, particularly in the more vulnerable thoracolumbar and lumbar regions. Meticulous fusion techniques, combining broad decortication with the addition of generous amounts of autogenous cancellous bone, likewise appear to provide a high percentage of solid fusions without disturbing the articular facets. Advocates of less meticulous, but more rapid, techniques of spine fusion have yet to prove the contention that such methods, when applied to scoliosis, will achieve results comparable to the more exacting and slower techniques by which the intervertebral articulations are carefully fused.

Of equal importance is the recognition and repair of pseudarthroses in the fused area. Orthopaedic surgeons who treat scoliosis must recognize their own fallibility and must not, through false pride or ignorance, close their eyes to the presence of these defects. When obvious, graft deficiencies should be repaired without delay. When graft deficiencies are suspected, it is best to explore surgically with great care and thoroughness, for hairline defects may be overlooked. The advantage of facet fusions in the recognition of pseudarthroses on roentgenographic examination is obvious, for open facets are readily visable on oblique views.

Recognition and repair of pseudarthroses before external corrective support is discarded will permit maintenance of curve correction. A single unrecognized pseudarthrosis will often result in complete loss of correction when external support is removed. Recorrection and repair of the defect is still entirely feasible.

The sudden loss of correction of a fused curve following an acute fracture of the graft and the ease with which recorrection and healing can be obtained has led to recorrection or further correction of a fused curve by posterior osteotomy of the graft. This has proved to be a very satisfying procedure.

Within the past decade, attempts have been made, both in Europe and in the United States, to obtain curve correction through the use of metal appliances inserted posteriorly in contact with the vertebrae. These have been in the form of adjustable jacks exerting distracting forces against the ends of the curve on its concavity, and contracting forces applied to the convex side of the curve. These efforts have reached their culmination in the United States in a multilevel combination apparatus which appears to be safe and successful in improving flexible curves. The method has also been shown to be successful in improving the more rigid structural curvatures. One may readily surmise that such instrumental correction, when shown to be without complications, may prove to be a useful addition to the methods of dealing with many problems in scoliosis. Certainly, internal correction of lateral curvatures of the spine is deserving of further study.

Extensive fusion in the young patient has been a subject of controversy. In my own experience, little actual increase in length of the fusion mass has been shown to occur with growth. Instead, all demonstrable growth of the vertebral bodies within the fusion area has been at the expense of the intervertebral-disc space. In extensive fusions in the young child, some disproportion in length of the trunk to the extremities has naturally occurred. However, such disproportion, in the presence of a relatively straight spine, is far less than is found in the collapsed spine of the severe scoliotic patient. Moreover, there appears to be little morbidity associated with such fusions, as related to the thoracic or abdominal viscera. No lordosis of clinical significance has thus far occurred in a considerable number of fusions performed in young children. Little loss of cor-

rection has occurred in such fusions which could not be explained on a basis of graft defects, short fusions, or fusions subjected to severe bending stress, such as that produced by uncontrollable pelvic obliquity. Where loss of correction has occurred, recorrection through osteotomy of the posterior fusion mass has produced excellent results. Nevertheless, because of growth cessation, fusion in the young child should be performed only on indications which leave no other alternatives in achieving a satisfactory end result.

While there is little of value in conservative measures in the treatment of severely progressive structural curves, there is much to be said in favor of conservative management of those curves which are seen early before structural changes are manifest. Many idiopathic curves, making their clinical appearance in early adolescence, show little evidence of deterioration and require little or nothing in the way of treatment other than close observation. The same is true for certain curves of congenital origin and even a few paralytic curves which never become deforming enough to require treatment. Curves in younger children, showing evidence of progression, can quite often be controlled throughout the growth period by the Milwaukee brace or by repeated cast correction. However, futile attempts at conservative management of severely progressive curves should be disparaged, whether in the hands of orthopaedic surgeons or physiatrists.

In recent years, clinical research carried out in the respiratory center at Rancho Los Amigos Hospital in Los Angeles, California, has effectively demonstrated the application of sound principles of surgical and respiratory physiology to the so-called inoperable patient with severe paralysis of the muscles of respiration. Through the teamwork of anesthesiologists and orthopaedic surgeons and nurses skilled in the use of automatic, positive-pressure respiratory apparatus combined with tracheostomy and the application of skeletal fixation of the skull by means of the "halo", the patient with the severely collapsing neck and spine may now safely receive the benefits of surgical spine stabilization. Wide experience with these problems at Rancho Los Amigos Hospital has shown beyond doubt that such planned teamwork will permit a wide variety of surgical procedures to be safely performed on these sorely neglected patients. In this issue of The Journal will be found another report from this institution, demonstrating the success with which the collapsing spine may be surgically stabilized in these severely handicapped individuals.

Scoliosis must no longer be the Cinderella of orthopaedic surgery. As orthopaedic surgeons, we must become cognizant of the great need for more intensive training in this important field. Methods of prevention and control of scoliogenic diseases are constantly being improved and expanded; and the techniques of correction, fusion, and rehabilitation of the scoliotic child are being made safer and more permanent. Let us hope that the application of the proved principles of treatment of scoliosis will steadily broaden.

JOHN H. MOE, M.D.

Stabilization of the Collapsing Spine*†

BY ALICE L. GARRETT, M.D., JACQUELIN PERRY, M.D., AND
VERNON L. NICKEL, M.D., DOWNEY, CALIFORNIA

From the Department of Orthopaedic Surgery, Poliomyelitis Clinical Study Center, Rancho Los Amigos Hospital, Downey

The ability to maintain an upright position is a major determining factor of a patient's function. Normally a person with a flexible spine depends upon the strength of his abdominal and spinal muscles to remain erect. If these muscles are totally paralyzed, motion between the vertebrae is uncontrolled. The consequent impairment of balance results in tremendous disability. Much greater effort is required to keep the head and shoulders balanced over the pelvis while sitting or standing, and the impaired trunk stability hampers motion of the extremities. These patients fatigue readily when upright. In order to document the effect of spinal stability on function, a group of patients with severe paralysis of the trunk muscles were evaluated before and after spine fusion.

Surgical stabilization of a collapsing spine is not new. As early as 1924, Hibbs described the functional benefits of spine fusion:

1. The upright posture is maintained with greater ease;
2. Trunk movement is accomplished with less fatigue;
3. There is a conspicuous relief from fatigue and unmistakable improvement in general physical well-being.

Later, in 1943, Cobb emphasized the importance of instability in the paralytic back and stated that fusion is often indicated for stabilization rather than for the degree of curvature.

In a child, an unstable spine almost inevitably results in scoliosis. Weakness of the trunk, together with flexibility, allows the spine to collapse when the patient is erect—the collapse occurring in the anteroposterior plane as well as in the lateral. Eventually the spine becomes fixed in the collapsed position and scoliosis is diagnosed.

All of the patients studied had a collapsing spine and many of them had fixed scoliosis. However, this paper is not concerned with the correction of scoliosis or with the surgical techniques for obtaining fusion; its purpose is to determine the value of stability of the spine in patients with paralyzed trunk muscles. The degree of correction of scoliosis had no correlation with functional improvement. In fact the few patients in whom the curve increased after spine fusion showed significant gains.

Trunk stability can be obtained by several means with varying degrees of efficiency. The simplest method is to preserve the stiffness characteristically present in acute and subacute poliomyelitis. These soft-tissue contractures, limiting motion between the vertebrae, afford a high degree of stability and substitute very effectively for even extensive muscle deficits. For this reason, passive stretching to regain a mobile spine should not be done early in the disease and should be completely avoided in patients with severe trunk paralysis [1]. In patients with normal or near-normal neck and back muscles, flexibility of the spine is useful and

* Read at the Annual Meeting of The American Academy of Orthopaedic Surgeons, Chicago, Illinois, January 26, 1960.

† Aided by an Annual Grant from The National Foundation.

desirable, but when paralysis exists to such a degree that the patient cannot hold himself erect or can do so for only short periods of time, then flexibility is a distinct disadvantage. We have found no evidence that stretching is necessary for muscle return.

In a growing child further support is generally necessary to preserve the stiffness. A plaster body cast will enhance the ability of patients with unstable spines to remain erect and will give them the necessary stability to use their extremity muscles. This is illustrated in a boy with muscular dystrophy in Figures 1-A and 1-B. Braces, when skillfully made and repeatedly adjusted, can also be effective, as exemplified by the work of Blount, Schmidt, Keever, and Leonard, and by that of Moe.

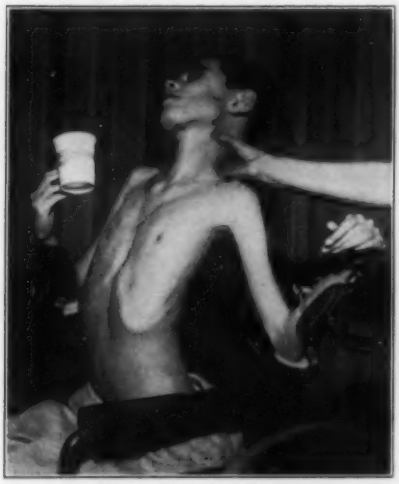


FIG. 1-A

FIG. 1-B

Figs. 1-A and 1-B: The effect of external support on a boy with an unstable spine due to muscular dystrophy.

Fig. 1-A: The patient is attempting to sit in his wheel chair unsupported.

Fig. 1-B: With a body jacket and head support, trunk stability is sufficient to enable the patient to manipulate balanced feeders and thus obtain arm function.

Spine fusion provides the greatest degree of stability and avoids the complications of prolonged external support.

MATERIAL

During the period January 1953 to July 1958, a total of seventy-nine patients underwent spine fusion at Rancho Los Amigos Hospital. In fifty-seven of these patients, the muscles of a major portion of the back were rated *poor* to *zero*; these patients, therefore, were considered to have trunk instability. Eight patients were excluded from the study because spine stability was not achieved following fusion. In these, additional surgery was done one to two years later to extend the fusion area or to repair a pseudoarthrosis. However, the prolonged elapse of time from the preoperative status until stability was finally obtained prevented an accurate comparison of function. Eleven other patients were not available for follow-up evaluation. The remaining thirty-eight patients were personally examined for the purpose of this study. In these thirty-eight patients, paralysis was due to poliomyelitis in thirty-four and to transverse myelitis in the upper thoracic area in four.

EXTENT OF FUSION

All patients had extensive fusions involving at least thirteen segments. Four fusions extended to the occiput and two to the sacrum. The shortest fusion was from the third thoracic to the third lumbar vertebra, and the longest from the occiput to the fourth lumbar vertebra.

In the earliest cases the fusion was done arbitrarily from the third thoracic to the third lumbar vertebra. Experience showed this area was frequently too short to control both the scoliosis and the instability. Subsequently the extent of fusion was determined for each patient according to the extent of the scoliosis and the location of trunk and neck paralysis. For example, in three patients with good

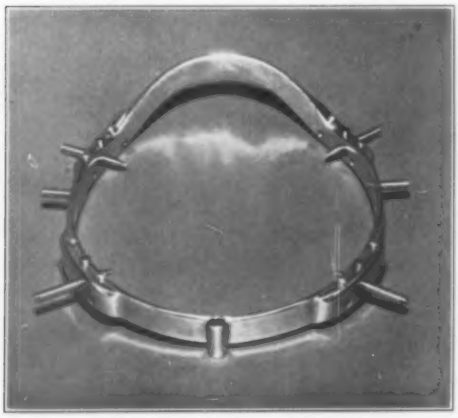


FIG. 2-A

Fig. 2-A: Before application of the halo to the patient (reprinted from Total Cervical-Spine Fusion for Neck Paralysis by Jacquelin Perry and Vernon Nickel, J. Bone and Joint Surg., **41-A:** 47, Jan. 1959).

Fig. 2-B: Halo attached to patient and cast.

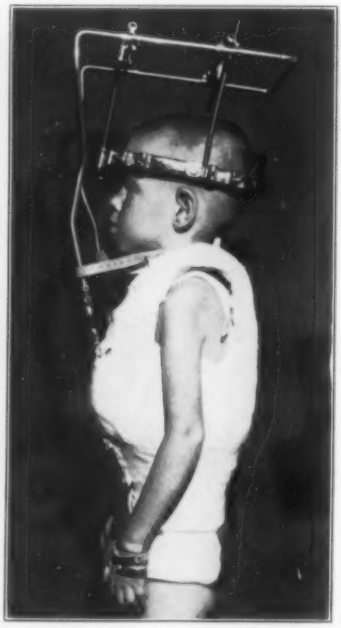


FIG. 2-B

lumbar and abdominal muscles and with a straight lumbar spine, the lower limit of fusion was the tenth thoracic vertebra. In three other patients with the same muscle strength, the fusion was carried to the fourth lumbar vertebra because the scoliosis extended into the lumbar area and the fourth lumbar vertebra was the first level vertebra. The upper end of the fusion was the second cervical or the third cervical vertebra in those with marked neck weakness; in four patients the occiput was included because the capital extensors were completely paralyzed. In those with strong neck muscles, the fusion terminated in the thoracic area.

TECHNIQUE

All patients had a Hibbs type fusion with destruction of the posterior portions of the facet joints. At first, bone was added only if the fusion was extended to the occiput or to the fourth lumbar vertebra. We now recommend addition of bone to the apex of the curve and to the lumbar area. We also more completely excise the facet joints.

A halo body cast (Figs. 2-A and 2-B) was used for immobilization in nineteen

patients and in all but two with fusions extending above the sixth cervical vertebra. The halo was attached by four screws to the outer table of the skull with the patient under general anesthesia. The following day a body cast was applied and connected by two metal uprights to the halo [8,10]. Application of the halo was done about two weeks before the first stage of the spine fusion. Two weeks prior to application of the halo a tracheotomy had been done.

The halo and cast were replaced after six months by a removable Minerva body cast. The cast was removed only for bathing in bed. Sitting, standing, and walking were then started, and the patient progressed to full activity in the cast by one year after the final stage of fusion. Use of the cast was then gradually discontinued; often a short removable cast was substituted for a few months. If a halo was not used, a non-removable body cast was worn during the first six months. Respiratory aid was used in all patients with vital capacities below 60 per cent of the normal. If a patient needed artificial respiration just during the immediate postoperative period while under sedation and narcotics, a tank respirator was used. The body cast was applied when the tank was no longer required. All patients regularly using respiratory aid and all those in halos were given positive-pressure air through a tracheostomy.

MORTALITY AND COMPLICATIONS

There was no operative mortality. However, two patients are now dead. One died twenty-five months and the other forty months after fusion. Both died at home and the exact cause of death is unknown. By history, both probably had respiratory infections.

Surgical complications peculiar to the technique described included infection around the halo pins and hyperventilation. None of the complications was serious and there were no recognizable sequelae. The halo is designed to allow three possible sites of insertion for each of the four screws. Drainage around the screws occurred but was controlled by inserting a new screw in the adjacent site approximately one centimeter away. In one patient the halo had to be removed six weeks after the last stage of fusion because of uncontrolled infection.

Convulsions developed in two patients in the immediate postoperative period. Both of these patients had borderline respiratory function. They were not using respiratory aid prior to surgery and chronic acidosis developed due to carbon dioxide retention. When artificial respiration was given during surgery and in the immediate postoperative period while they were under heavy sedation, a mild alkalosis from hyperventilation resulted in convulsions. This complication has since been avoided by the use of respiratory aid for a longer period before surgery, allowing the patient to accommodate physiologically to more normal carbon dioxide levels.

RESULTS

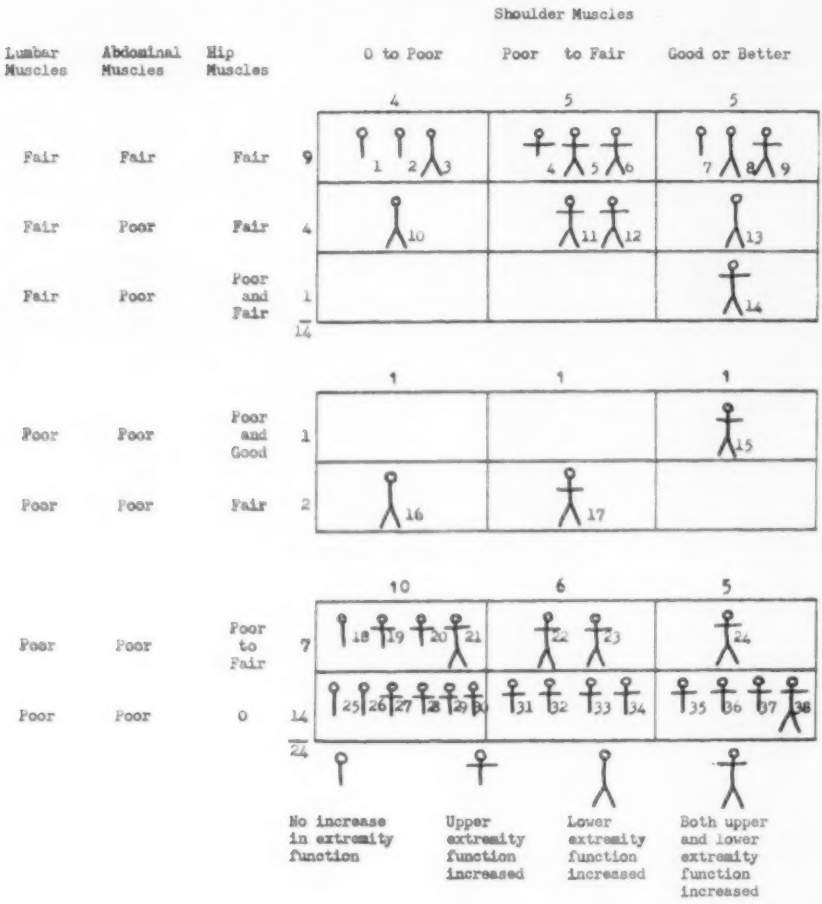
At the time of fusion, the ages ranged from four to forty-eight years, with a mean age of thirteen. All patients were examined between one and one-half and four years after operation.

Twelve of the patients had abdominal fascial transplants, and one had intrascapular fascial transplants, in addition to spine fusion. Increases in function, therefore, also reflect the effects of these procedures, which we believe have added further to stability.

The functional gains in the thirty-eight patients studied were based on the following factors: lower-extremity function, upper-extremity function, endurance, and respiratory function.

TABLE I

Gains in Extremity Function *



* The numbers beside each symbol are case numbers and are used to designate specific cases in the text.

Head balance is another important aspect of spine stability which will not be discussed here as it was the subject of a previous paper [10].

Lower-Extremity Function

Lower-extremity function (Table I) was judged by walking distance, frequency of falling, and ability to arise from the floor. The influence of trunk stability on these activities was demonstrated by each patient's gains after surgery and by correlating residual trunk strength with preoperative abilities. The relative strength of the lumbar muscles was a major determinant of the patient's ambulatory status. Strength of the abdominal and hip muscles were also important factors. The back muscles in the thoracic area were markedly weak in all of the patients.

Prior to fusion fourteen patients whose lumbar extensors were rated at least *fair* were able to walk. In nine of these patients (Cases 1 to 9) the abdominal and

FIG. 3-A

FIG. 3-B

Figs. 3-A and 3-B: K. M. Paralysis of the muscles of the neck and upper part of the back with good lumbar and lower extremity muscles.
Fig. 3-A: Note amount of assistance required to stand before operation.
Fig. 3-B: Fifteen months after spine fusion from the occiput to the third lumbar vertebra, the patient is able to stand and walk without assistance.

hip muscles were rated *fair* or better. Of the nine, four were unlimited in walking distance and could arise from the floor without difficulty (Cases 1, 2, 4, and 7); two could not get up from the floor but were unrestricted in walking (Cases 6 and 9) and three were limited both in walking distance and arising from the floor (Cases 3, 5, and 8). Five patients with abdominal muscles rated *poor* or less were able to walk but were limited in walking distance (Cases 10 to 14). These five had hip muscles rated at least *fair*, except one with muscles about one hip rated *poor* and the other rated *fair* (Case 14).

After fusion all fourteen patients walked without fear of falling and without restriction. All but two were able to arise from the floor; these had *poor* abdominal strength (Cases 11 and 12). Upper-extremity strength of these fourteen patients varied from *zero* to *good* or better and was not related to ability to walk.

Twenty-four patients had lumbar muscles rated *poor* to *zero* and had equally weak abdominal muscles. Two patients with hip muscles rated *fair* walked short distances with difficulty prior to fusion but after fusion were able to walk without restriction (Cases 16 and 17). One other patient made a similar gain. He had a good right upper extremity and a good left lower extremity with marked weakness of the other limbs. Before operation he could walk short distances with a crutch; after fusion he could walk without support for an unlimited distance (Case 15).

Seven others had muscles about the hips rated *poor* to *fair*. After spine fusion four progressed from a few guarded steps under supervision to independent walking indoors with crutches (Cases 21, 22, 23, and 24). Arm function ranged from *poor* to *good* in this group. The other three, two of whom had a flail upper extremity, were not able to walk (Cases 18, 19, and 20).

FIG. 4-A

FIG. 4-B

Figs. 4-A and 4-B: R. S. Complete paralysis of the muscles of the neck and back.
Fig. 4-A: Note assistance required to sit before operation.
Fig. 4-B: Two years after spine fusion from the occiput to the fourth lumbar vertebra the patient can sit without assistance and without using his hands.

Fourteen patients had flail lower extremities bilaterally. One of four with normal upper extremities could walk with crutches for short distances after fusion (Case 38). The other thirteen remained wheel-chair patients (Cases 25 to 37, inclusive). Thus of the twenty-four with both lumbar and abdominal muscles rated *poor* to *zero*, three became fully ambulatory, five gained the ability to walk for limited distances indoors (Cases 21, 22, 23, 24, and 38), and sixteen remained full-time wheel-chair patients.

The patients making the greatest gains were those who had functional lower extremities but poor trunk balance. Stabilization of the spine enabled them to make full use of the residual power of the lower extremities.

The following patient is a typical example of this group:

CASE 3. K. M. had marked weakness of both upper extremities, the neck, and upper back; she had *fair* abdominal muscle power, *good* lumbar extensor muscles, and functional lower extremities. She was unable to walk or even to sit up without external support prior to surgery. With a body jacket and head support she could walk in quiet surroundings for a limited period of time. At the age of ten, one and one-half years after the onset of poliomyelitis, a spine fusion from the occiput to the third lumbar vertebra was done. At the time of writing, three years after fusion, she could walk without restriction and attended regular school (Figs. 3-A and 3-B).

Upper-Extremity Function

Improvement in upper-extremity function (Table I) was determined by ability to use feeders, ease of transfer from bed to wheel chair, and strength of arm elevation. Two factors appeared to influence function; the ability to walk and the degree of shoulder paralysis.

There were seventeen patients (Cases 1 through 17) who were fully ambula-

tory after surgery. No improvement in the upper extremities was noted in the five fully ambulatory patients whose shoulder muscles had been rated *zero* to *poor* (Cases 1, 2, 3, 10, and 16).

Five of the six fully ambulatory patients with muscles rated *poor plus* to *fair* in at least one shoulder showed an increase in the muscle power in that shoulder (Cases 4, 5, 6, 12, and 17). The sixth patient had no apparent change in strength but after fusion he was able to use his arms without first sitting down (Case 11). This was a tremendous functional gain for this boy, for he was able to defend himself from his younger brother.

The other six fully ambulatory patients had muscle strength rated *good* in at least one shoulder. After spine fusion shoulder strength increased in two patients (Cases 9 and 14). One other was able to discard a previously needed crutch, thereby freeing his one good arm for activity while standing (Case 15). The remaining three patients showed no gains in upper-extremity function (Cases 7, 8, and 13).

In the group not fully ambulatory (Cases 18 to 38 inclusive), eighteen out of twenty-one patients gained in upper-extremity function. The three patients who did not improve had shoulder muscles rated *zero* to *poor* but were already adept in the use of feeders prior to fusion (Cases 18, 25, and 26). The other seven patients with shoulder muscles rated *zero* to *poor* demonstrated an increase in upper-extremity strength resulting in better control of feeders (Cases 19, 20, 21, 27, 28, 29, and 30). Two of these patients could not be fitted with feeders until after surgery because fatigue prevented them from sitting (Cases 20 and 27).

Of the six patients with *poor* to *fair* strength in the muscles of at least one shoulder (Cases 22, 23, 31, 32, 33, and 34), all were able to sit without using their arms for balance, and four described an actual increase in strength (Cases 22, 23, 31, and 34).

One patient with one *fair* and one *good* shoulder (Case 24), and four with upper extremities rated *normal* (Cases 35, 36, 37, and 38) demonstrated improved sitting balance, thereby freeing their arms for other activities. Three of these patients also noted an increased ease of transfer from wheel chair to bed (Cases 24, 35, and 38).

Figures 4-A and 4-B show a boy (Case 29) with severe involvement of the trunk and all four extremities. He was unable to sit up without support. After spine fusion from the occiput to the fourth lumbar vertebra he was able to sit all day in his wheel chair. His right arm, with shoulder muscles rated *poor*, increased in strength and in the ability to control his balanced feeders.

The non-ambulatory patients, then, noted the greatest increases in upper-extremity function. Muscle weakness in both the lumbar and thoracic areas made trunk balance more precarious, requiring most of the patients to use their arms for support. When stability was provided by fusion, their arms were freed for useful activities.

In the group with shoulder muscles rated *zero* to *poor*, only the wheel-chair patients noted improvement, probably because feeders make even minimal power useful. All patients with shoulder muscles rated *poor plus* to *fair*, whether walking or not, showed an increase in function, while only half of the ambulatory patients with greater shoulder power noted an improvement. A possible explanation is that small increases in strength were more apparent in the group with borderline function.

In summary, function in thirteen patients was increased in both the upper and lower extremities; fourteen patients noted a gain in function of the upper extremities only; and five noted a gain in function in the lower extremities only. Six pa-

tients failed to demonstrate any change in the use of any of their extremities. Three of the six (Cases 1, 2, and 7) could walk without restriction prior to surgery. Two of these (Cases 1 and 2) had shoulder muscles rated *zero* to *poor* and one (Case 7) had one good and one poor shoulder. The other three (Cases 18, 25, and 26) were adept in the use of feeders before surgery and had hip muscles rated *zero* to *poor*, which prevented walking.

Endurance

Endurance was improved in thirty of the thirty-eight patients despite increased activity. The patient's endurance was estimated by the number of rest periods taken during the day, the amount of fatigue present in the evening, and the duration of sitting tolerance.

TABLE II

VITAL CAPACITY CHANGES AND ENDURANCE INCREASE

	Vital Capacity		
	Decrease	Same	Increase
Increase in endurance	1	10	14
No change in endurance	1	2	3

In the fully ambulatory group of seventeen patients (Cases 1 to 17 inclusive), two decreased the duration and frequency of rest periods (Cases 3 and 6), and eight were able to eliminate them altogether (Cases 2, 5, 11, 12, 13, 14, 16, and 17). Of the remaining seven, none of whom rested during the day before fusion, three noticed less fatigue in the evening (Cases 8, 10, and 15) and four did not gain (Cases 1, 4, 7, and 9). The five partially ambulatory patients (Cases 21, 22, 23, 24, and 38) noted less fatigue in the evening, and one no longer took a rest period (Case 23). Sitting time was increased in the eleven wheel-chair patients whose sitting time was previously limited. Five of these were also able to eliminate rest periods (Cases 20, 25, 26, 28, and 29) and two to decrease rest periods (Cases 19 and 34). Less evening fatigue was described by another patient whose sitting time was unlimited (Case 37). The remaining four of the thirty-eight patients did not gain (Cases 18, 31, 35, and 36).

Of the eight who did not improve, six were not aware of limited endurance before fusion, four being fully ambulatory (Cases 1, 4, 7, and 9) and two sitting in wheel chairs all day long (Cases 31 and 35). However, one of the two wheel-chair patients could sit only six hours without a body jacket (Case 31). The remaining two continued to require rest periods following fusion. Both were non-ambulatory patients, one with shoulder muscles rated *zero* to *poor* who did not gain in function (Case 18) and the other with normal shoulder muscles whose improved sitting balance permitted greater use of his arms (Case 36).

Respiratory Function

The striking clinical improvement in breathing was not reflected by any of the practical laboratory tests known today. The respiratory department at Rancho Los Amigos Hospital, among others, is continuing the study of this problem in an attempt to obtain more definite objective data.

Thirty-one of our patients had vital capacities below 60 per cent. The lack of correlation between the changes in vital capacity of these patients and the clinical evaluation of their endurance is illustrated in Table II. Of the patients with in-

creased endurance, fourteen had an increase in vital capacity, but ten remained the same, and one even had a decrease in vital capacity. Differences of less than 100 cubic centimeters are listed as the same.

The discrepancy between changes in vital capacity and function is well illustrated by the history of a twelve-year-old girl (Case 13) who, prior to surgery, required a recumbent rest period after two hours of activity. After spine fusion, she needed no rest periods and returned to a regular school, but her vital capacity has remained relatively unchanged. During the past four years this level of activity has been maintained, although unfortunately her curvature has continued to progress due to a pseudarthrosis.

The increased functional capacity in this patient is, in our opinion, clearly due to the stability obtained.

Prior to fusion, ten patients were hospitalized at least twice for atelectasis or pneumonia. Of these, all but one improved following fusion, with no further admissions to the hospital. Our explanation for this improvement is that these patients now tolerated the erect position for longer periods of time, could be turned with greater comfort and ease, and exhibited less fatigue. These factors, we believe, increased the resistance to respiratory infections.

The one exception just listed is a patient whose breathing was accomplished primarily by the intercostal muscles as compared with the other nine who breathed primarily with their diaphragm, neck, or abdominal muscles. This patient, we believe, was more adversely affected by the restriction of chest motion required by the postoperative immobilization.

Any type of external trunk support must of necessity exert pressure on a chest wall, and it is obvious that patients with severe respiratory paralysis are harmed by such pressure. A study by Gucker showed that vital capacity is reduced 7 to 46 per cent by corrective casts. At Rancho Los Amigos Hospital we have found that even a supportive cast may cause some reduction. This loss may become permanent if there is prolonged restriction of chest expansion in the face of weak intercostals.

In order to be alert to this danger, respiratory function should be carefully investigated in all patients with a possible respiratory deficit. This investigation should include patients with severe paralysis of shoulder and trunk muscles because these patients frequently have respiratory-muscle involvement.

Previous papers [7,8] showed that with mechanical respirators and adequate replacement of blood, extensive operative procedures can be done safely, regardless of the severity of respiratory paralysis. Therefore, spine fusion need not be denied any patient with a collapsing spine.

Solid fusion is obtained much more readily, with a shorter period of immobilization and less chest constriction, if surgery is done before the curvature has become severe. As Hibbs stated over thirty-five years ago, spine fusion should be done early, it being easier to prevent than to correct deformity.

Rather than wait for the development of scoliosis, instability itself should be an indication for spine fusion. The ease with which a patient can balance his head and trunk determines to a great extent the degree to which he can develop the residual power of his extremities.

If less energy is required to maintain the erect posture, the demands on respiratory function are decreased, fatigue is less, and the patient's efforts can be directed toward productive activities.

To give stability to the paralyzed trunk, therefore, is a first consideration. Back tightness should be preserved if any weakness is present. A spine fusion should be performed if collapse occurs, before the collapse becomes a fixed scoliosis.

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DISCUSSION

Dr. John H. Moe, Minneapolis, Minnesota: I wish to congratulate Dr. Garrett, Dr. Perry, and Dr. Nickel for their presentation of a highly instructive work on patients with paralytic collapsing spines. A visit to Rancho Los Amigos Hospital, where this work has been done, convinces the most skeptical of the enormity of the problems with which Dr. Nickel and his associates have been faced and of their courage and skill in meeting and in overcoming these problems.

Dr. Garrett, Dr. Perry, and Dr. Nickel have demonstrated the safety of major surgical procedures performed on patients with major respiratory deficits. When these patients are carefully evaluated and are given the necessary respiratory aid before and after operation, the safety of these procedures has been established. They have extended the benefits of stabilization of the collapsing spine to numerous patients previously considered beyond surgical help. The benefit which these patients receive from such stabilization is usually tremendous.

Since visiting with Dr. Nickel at Rancho Los Amigos Hospital two years ago, I have endeavored to apply his teaching and experience on my Scoliosis Service at Gillette State Hospital and at the University of Minnesota. I have found the halo as devised and used at Rancho Los Amigos Hospital a safe and most efficient means of maintaining distraction upon the head in these severely involved patients. We have obtained the help and full cooperation of the Department of Anesthesia at the University of Minnesota in properly evaluating pulmonary function in these patients. We have come to rely on the judgment of these anesthesiologists in determining the need for respiratory assistance. The need for team work in this difficult field is very real.

The collapsing spine has been a familiar problem to all orthopaedic surgeons who have dealt with scoliosis or with the major paralytic problems in children, adolescents, and even adults. For the most part, treatment in the past has been that of neglect.

The authors have mentioned the desirability of preserving the stiffness so often found in the trunk in subacute poliomyelitis. This statement must be carefully interpreted. It must be recalled that many victims of paralytic poliomyelitis who exhibit generalized paralysis make a partial or even a spectacular recovery. The preservation of stiffness in some of these would be undesirable. Likewise, the preservation of stiffness due to or accompanied by undesirable contractures should be avoided. My own feeling is that there may be many undesirable features in this method of approach to the treatment of collapsing spine or of the prevention of severe scoliosis in the growing child. It would undoubtedly have a wider application in the paralyzed adult.

Patients with progressive disease, such as muscular dystrophy and certain forms of congenital amyotonia, accompanied by collapse of the spine have not been enthusiastically received as candidates for spine stabilization in past years. On the other hand, futile attempts at external support of these collapsing spines have been made by most orthopaedic surgeons. I feel that we should warmly accept the suggestion made by these authors that these patients are often good candidates for spine stabilization. I am sure that these young patients will welcome the opportunity to again sit upright. I am sure that whatever muscle power remains in their extremities will be made more functional by such stabilization. Perhaps, even their span of life will be materially increased thereby.

This is a timely subject for orthopaedic surgeons. I cannot be at all critical of this paper. I approve of what the authors have presented, and I think they should be commended for their fine work.

Grease-Gun Injuries of the Hand*

BY HERBERT H. STARK, M.D., JAMES N. WILSON, M.D., AND JOSEPH H. BOYES, M.D., LOS ANGELES, CALIFORNIA

Penetrating wounds caused by grease or oil injected into the fingers and hand are uncommon. Since the first description in 1937 [14], eighteen case reports have appeared in the English literature; four injuries were caused by injection of diesel fuel [6,9,14] and fourteen injuries were caused by injection of lubricating oils [1,2,4,8,10,11,12,15,16,17]. Photographs of a few other injuries, together with brief descriptions of them, have been included in textbooks of hand surgery [3,5,7,13]. Harrison is undoubtedly correct in his belief that such injuries occur more often than they are reported. We have treated five patients with grease-gun injuries of the hand during the past six years. The purpose of this paper is to report our experience with these injuries, to emphasize their seriousness, and to stress that immediate surgery is the best method of treatment.

The lubrication of machines and the carburetion of diesel engines are accomplished by forcing a fine stream of grease or oil under high pressure through a tiny opening. If the jet stream strikes the hand or finger, it pierces the skin and fills the tissue spaces with oil or grease. The extent of damage may not be apparent at the time, and the patient often continues to work. Within a few hours, however, pain becomes intense, and the injured part becomes numb and pale. In closed spaces, such as the pulp of the finger tip, ischemia develops rapidly.

In 1941, Mason and Queen gave a detailed description of the tissue changes that follow such injuries. Damage to the hand is caused by ischemia, chemical irritation, and infection. Sudden distension produces ischemia which, if unrelieved, causes tissue necrosis. Immediate removal of the retained grease decompresses the injured part, lessens the tissue irritation, and rids the wound of contaminated material.

Acute grease-gun injuries should be treated as surgical emergencies. From a tiny opening, grease will disseminate through the tissues; it will not necessarily follow anatomical soft-tissue planes. The palm and wrist may be distended with grease that has entered a finger. If the entry is in the mid-volar line of a finger, the flexor-tendon sheath may be filled with grease or oil throughout its length. Unless the pressure is relieved the tendon will die, even though infection does not supervene.

Small incisions over the point of entry are inadequate. All involved parts should be thoroughly explored in a bloodless field. A finger should be opened through a mid-lateral incision throughout its length and, if involved, the palm should be opened through an appropriate separate incision. All possible foreign material should be mechanically removed: a blunt curette is the most useful tool. Impregnated, non-essential tissue should be sharply excised. Damaged tendon sheaths should be removed, and only small proximal and middle segment pulleys should be preserved. Even with meticulous care and the utmost patience, some foreign material will still remain. We have not used oil solvents, such as ether, because we believe that such solvents are harmful to living tissues. The incisions should be loosely closed, and the hand should be immobilized in a position of function. Tetanus antitoxin or toxoid should be given.

* Read at the Annual Meeting of the Western Orthopedic Association, Coronado, California, October 25, 1960.

CASE 1 (Figs. 1-A through 1-F): An aircraft mechanic, thirty-three years old, was first seen two days after grease, under pressure of 3,000 pounds per square inch, had entered the volar surface of the right long finger at the proximal flexion crease. The entire long finger and the distal portion of the palm were swollen. The dorsal skin over the proximal segment of the finger was blistered; and the index, long, and ring fingers were numb.

FIG. 1-A

Case 1. The dorsal skin was blistered and swollen forty-eight hours after grease had entered the volar surface of the long finger.

FIG. 1-B

FIG. 1-C

Fig. 1-B: The dorsum of the finger was filled with grease, the mechanical removal of which was facilitated by use of a curette. Note the ischemic necrosis on the dorsum.

Fig. 1-C: The volar soft tissues were infiltrated with grease, but the tendon sheath was intact. A probe is beneath the digital nerve.

The long finger was opened through a mid-lateral incision. The dorsal and volar soft tissues of the finger were distended with thick grease, but the tendon sheath was intact. The palm, which was opened through a separate incision, was also filled with grease. As much grease as possible was removed from both the finger and the palm with a curette and by sharp excision. The wounds were loosely closed and healing was uncomplicated.

Eleven months after injury extension of the finger was normal and voluntary flexion brought the finger tip to within one-quarter inch of the mid-palmar crease.

Only four of the eighteen cases reported in the literature were treated by early and adequate surgery. In these four there was a reasonably satisfactory result, although no patient had a full range of motion in the injured finger [1,6,10,12]. By contrast, when similar injuries were treated by conservative measures, amputation was usually required.

FIG. 1-D

The distal portion of the palm was exposed through a separate incision. The soft-tissue spaces were distended with grease and adjacent neurovascular bundles were compressed. Immediate decompression is mandatory to prevent irreversible ischemia.

FIG. 1-E

As much grease as possible was removed with a curette, and all impregnated non-essential tissue excised. Complete removal of the grease was impossible.

FIG. 1-F

Eleven months after injury, all fingers extended normally. The long finger flexed to within one-quarter inch of the mid-palmar crease.

Case 2: A machinist, who worked on oil well pipelines, was seen after unrefined oil delivered at a pressure of 15,000 pounds per square inch through a one-thirty-second-inch opening struck his right index finger on the radial side of the middle flexion crease. The hand swelled. Roentgenograms

FIG. 2-A

FIG. 2-B

Fig. 2-A: Case 3. The tendon sheath in the finger and palm was distended with grease; the sheath in the palm ruptured, and grease extravasated into the soft tissues.

Fig. 2-B: The appearance of the tendon after partial removal of the sheath. Grease contained within the sheath exuded from the opening.

FIG. 2-C

The appearance of the finger thirteen months after injury. Motion remains extremely limited.

showed air in the dorsum of the finger and hand; a diagnosis of gas gangrene was made. The patient was treated with gas antitoxin and antibiotics.

Ten days later, on our first examination, the index finger was already gangrenous; and the dorsum of the hand was swollen, particularly over the metacarpal of the index finger. The finger was amputated through the base of the metacarpal. Grease had extended along the radial neurovascular bundle into the palm. The flexor-tendon sheath was intact, although surrounded by the foreign material. Considerable grease was found on the dorsum of the proximal segment of the finger and between the metacarpals of the index and long fingers. Healing was uneventful.

Decompression by removal of the foreign material will usually prevent gangrene. Since complete removal is not possible, some fibrosis and scarring usually occur. If the flexor-tendon sheaths are directly involved, as in the following case, considerable loss of function is more likely.

CASE 3 (Figs. 2-A through 2-C): A gas station attendant, twenty-nine years old, was seen forty-eight hours after a jet stream of grease from a lubricating gun had penetrated the palmar aspect of the base of his left long finger. The patient stated that half a cup of grease had previously been expressed from the wound opening. At operation, the flexor-tendon sheath was found to be distended from the finger tip to the proximal part of the palm. Large amounts of grease and a

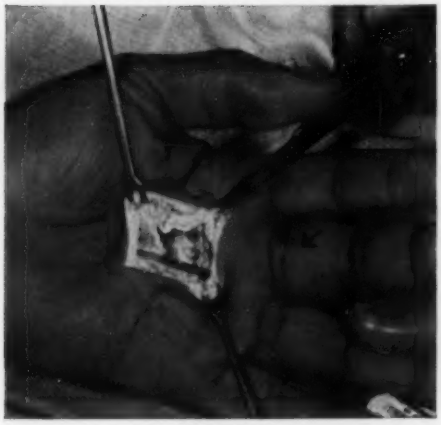

FIG. 3-A

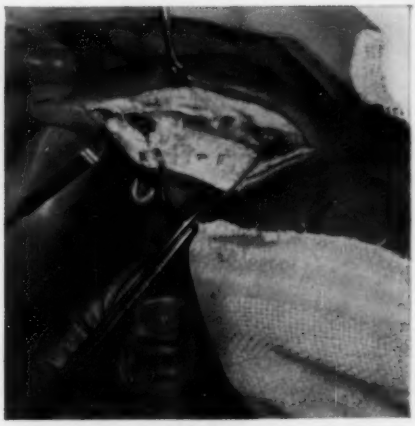

FIG. 3-B

Fig. 3-A: Case 4. The left hand twelve days after grease had penetrated the long finger. The wound of entry was inconspicuous (arrow). The tendon sheath in the palm was distended with grease.

Fig. 3-B: The tendon sheath in the finger was also distended: all grease was contained within the tendon sheath.

Fig. 3-C: The grease has been removed, and the major portion of tendon sheath is being excised. Pulleys were preserved.

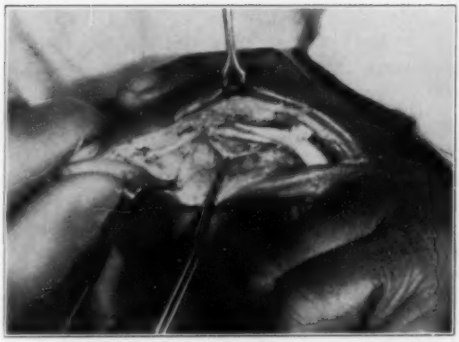

FIG. 3-C

smaller amount of purulent-appearing material were removed through two incisions—one in the finger, the other in the palm. The tendon sheath was excised, but narrow pulleys in the proximal and middle segments of the finger were preserved. The palmar incision was loosely closed over a drain; the finger incision was closed loosely without drainage. The purulent-appearing material was probably emulsified fat [12], since no organisms were reported from cultures of this material. Primary healing occurred, but motion of the long finger was greatly restricted. Six months later an attempt was made to improve flexion by tenolysis. There was extreme scarring throughout the entire finger and palm, which severely compromised the results of the second procedure. Thirteen months after injury, the long finger could only be flexed voluntarily to within two inches of the mid-palmar crease. There was negligible motion of the two interphalangeal joints, but, since these joints were in partial flexion, the patient was able to use the finger for many activities and did not desire amputation.

When a patient is seen several days after injury and salvage of the parts seems feasible, immediate removal of the retained grease will minimize the inevitable fibrosis and prevent the formation of chronic, draining olemata [11].

CASE 4 (Figs. 3-A through 3-C): An airplane factory worker, fifty-two years old, was seen ten days after a jet of lubrication oil from a high-pressure grease gun had penetrated the volar surface of the proximal segment of his left long finger. First-aid treatment had consisted in expressing grease from the small wound of entry. On examination ten days after injury there were numbness and swelling of the finger, swelling in the distal part of the palm, and marked stiffness of all fingers.

At operation, the tendon sheath of the long finger was found to be filled with grease; complete removal of the grease was impossible and the tendon sheath was excised. The wounds healed with-

FIG. 4-A

FIG. 4-B

Fig. 4-A: Case 5. Photograph shows a necrotic wound with exposed profundus tendon, five weeks after grease penetrated the long finger near the distal flexion crease.
Fig. 4-B: The finger was salvaged by resurfacing with an abdominal pedicle flap.

out complication, but five months after injury there was still marked stiffness of all fingers.

In neglected cases, amputation is often the best treatment, but occasionally reconstruction is indicated and the result rewarding [16].

CASE 5 (Figs. 4-A and 4-B): An oil well worker, thirty-three years old, was seen five weeks after a jet stream of carbonox—a mixture of soda lime, dry clay, oil, and water—delivered at 650 pounds of pressure, had penetrated the volar surface of the right long finger near the distal flexion crease. Initial treatment was reported as being wound débridement. Examination showed an extensive defect of the skin with exposed flexor tendons—the result of unrelieved ischemia.

After resurfacing the volar surface of the distal part of the finger with an abdominal pedicle flap, the distal joint was fused, the profundus tendon was excised, and the sublimis tendon was freed from scar tissue. Useful function was restored and the finger tip flexed voluntarily to within one inch of the mid-palmar crease. The finger tip, however, was numb due to irreparable nerve damage.

SUMMARY

Grease-gun injuries are an undesirable side effect of our modern machine age. Since methods of high-pressure lubrication are used in automobile, airplane, and missile industries, more such injuries can be expected. The seriousness of these injuries should be recognized so that prompt and adequate treatment can reduce the resulting disability.

Grease-gun injuries of the hand are best treated by immediate surgical removal of as much of the grease as possible. This will prevent ischemic gangrene and reduce fibrosis and scarring.

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Compression Arthrodesis of the Hip Joint

A Preliminary Report

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The purpose of this preliminary report is to describe a method of internal fixation with compression for arthrodesis of the hip joint. The firm internal fixation is provided by a massive three-flanged nail which prevents movement at the hip in every direction, including flexion and extension motions, which are possible, at least theoretically, when only a screw is used [2]. The compression is provided by the apparatus to be described, which brings the surfaces of the bones to be fused into firm contact; thus, external immobilization is rarely necessary. Mobilization of the knee can be started immediately after operation, and walking with crutches can be permitted soon after operation.

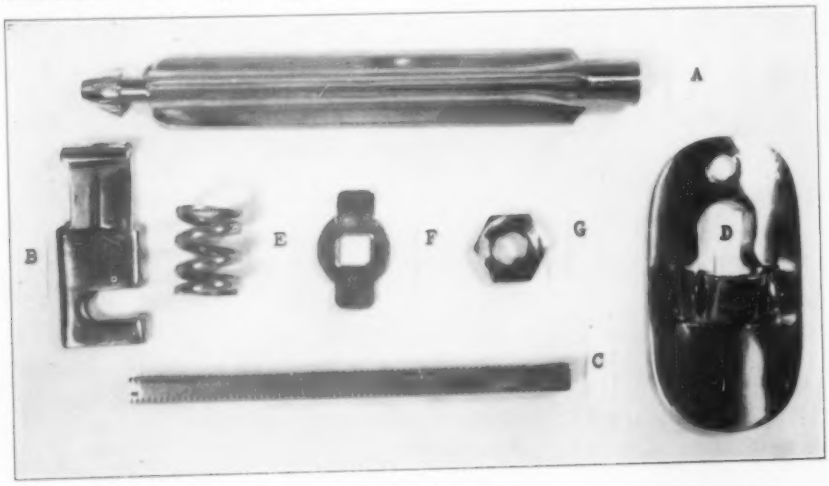

FIG. 1

The unassembled compression apparatus, made of antimagnetic stainless steel with molybdenum (SMO): *A*, the cannulated, massive, three-flanged compression nail, 1.8 centimeters in diameter and from five to twelve centimeters in length, although the length most commonly used is from nine to eleven centimeters; *B*, the stop-plate, consisting of a rider inside a sleeve with a lateral opening to receive the neck of the compression nail; *C*, the cannulated quadrangular (square) compression screw, nine centimeters long and 0.8 centimeter in diameter; *D*, the compression plate, with a square opening in a jointed inlet to receive the square compression screw (this movable inlet adjusts itself to the angle of inclination formed by the compression screw and the femur); *E*, the spring for compression from twelve to twenty-four kilograms in strength; *F*, the winged lock washer; and *G*, the nut.

INSTRUMENTS

The compression apparatus, made of antimagnetic stainless steel with molybdenum (SMO), consists of a cannulated, massive, three-flanged nail (Fig. 1, *A*), 1.8 centimeters in diameter, which is available in lengths from five to twelve centimeters; a stop-plate (Fig. 1, *B*); a cannulated, quadrilateral compression screw, nine centimeters long and 0.8 centimeter in diameter (Fig. 1, *C*); a compression plate (Fig. 1, *D*); a compression spring, available with variable strengths

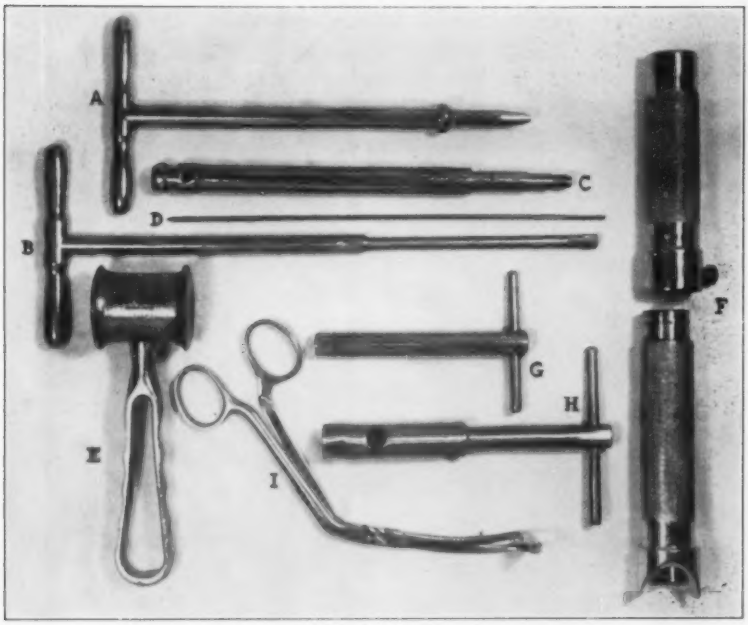

FIG. 2

The instruments for the insertion of the compression nail and apparatus: *A*, the cannulated hand drill, 1.1 centimeters in diameter, used to make a clearance hole in the femoral cortex; *B*, a cannulated hand drill, 0.8 centimeter in diameter; *C*, the introducer for the compression nail; *D*, the guide wire; *E*, the mallet; *F*, the modified Smith-Petersen impactor with an extension; *G*, the hollow spanner for inserting the compression screw; *H*, the hollow spanner for the nut; and *I*, the clamp (two are used) for application of the stop-plate.

ranging from twelve to twenty-four kilograms (Fig. 1, *E*); a winged lock washer (Fig. 1, *F*); and a nut (Fig. 1, *G*).

The tools for the insertion of the apparatus include a cannulated hand drill, 1.1 centimeters in diameter, used to make a clearance hole in the femoral cortex (Fig. 2, *A*); a cannulated hand drill, 0.8 centimeter in diameter, used to drill a hole for the nail in the neck, head, and pelvis (Fig. 2, *B*); a nail introducer (Fig 2, *C*); a guide wire (Fig. 2, *D*); a mallet (Fig. 2, *E*); a modified Smith-Petersen impactor with extension (Fig. 2, *F*); a hollow spanner, used to insert the compression screw (Fig. 2, *G*); a hollow spanner for the nut (Fig. 2, *H*); two clamps (one shown) for application of the stop-plate (Fig. 2, *I*); and heavy-duty double-action chrome vanadium bolt cutters, with handles seventy centimeters long.

The tools for extracting the apparatus consist of a stop-plate extractor (Fig. 3, *A*); a nail extractor (Fig. 3, *B*); a mallet (Fig. 3, *C*); a modified Smith-Petersen nail extractor (Fig. 3, *D*); and a pair of pliers (Fig. 3, *E*).

OPERATIVE TECHNIQUE

The operation is carried out through the Smith-Petersen incision with the patient on a fracture table to facilitate the final positioning of the hip for arthrodesis. The hip joint is approached between the sartorius and tensor fasciae latae the latter being stripped off the ilium together with the gluteal muscles while the sartorius is reflected from the anterosuperior iliac spine with the inguinal ligament. The periosteum is reflected and stripped off the internal wall of the pelvis.

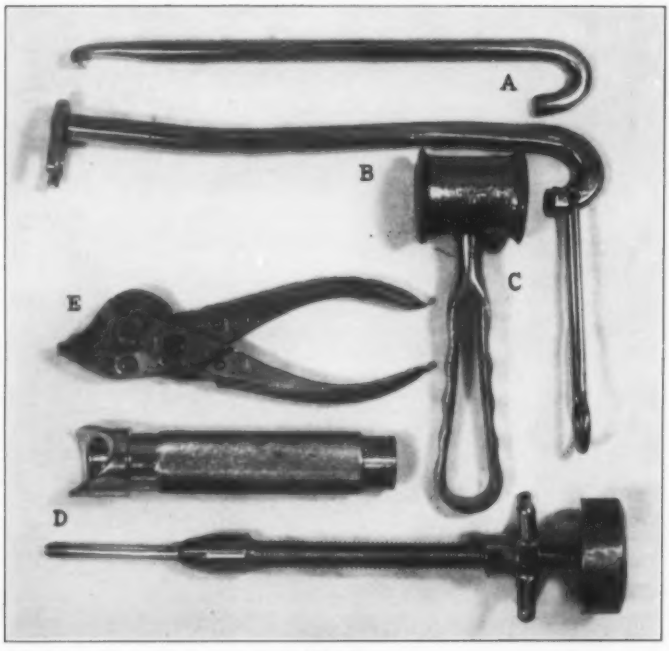

FIG. 3

Tools for the extraction of the compression nail and apparatus: *A*, the stop-plate extractor; *B*, the compression nail extractor; *C*, the mallet for the nail extractor; *D*, the modified Smith-Petersen compression-nail extractor; and *E*, pliers.

The rectus femoris muscle is removed from its two origins for better exposure of the joint. The anterior one-half of the capsule, or more if an iliofemoral graft is to be used, is excised, the joint is dislocated, and the cartilage is removed from the head of the femur and from the acetabulum.

The femoral head is then replaced in the acetabulum and the position in which the hip is to be arthrodesed is selected (unless indicated otherwise, I fuse the hip in neutral position or slight adduction, in neutral or slight external rotation, and in 20 to 30 degrees of flexion).

Through a separate incision, the lateral aspect of the proximal part of the femur is exposed and a guide wire is driven from below the greater trochanter through the neck and head of the femur and into the acetabulum until its point emerges from the inner wall of the pelvis. That point of the guide wire is then grasped with a heavy Kocher clamp, and a large abdominal retractor is placed to hold the soft tissues away from the inner aspect of the acetabulum and to serve as a precaution against the possibility of the guide wire being driven into the abdominal cavity during the forthcoming steps of the operation. Care must be taken not to drive the guide wire either too low or too far posteriorly in the neck of the femur since it will then emerge deep inside the lesser pelvis, making application of the stop-plate to the neck of the nail difficult.

With the clearance drill (Fig. 2, *A*) slid over the guide wire, the opening in the lateral cortex of the femur is enlarged to facilitate the subsequent introduction of the nail. The drill is advanced until its shoulder reaches the cortex; it is then withdrawn. The 0.8 centimeter drill (Fig. 2, *B*) is now placed over the guide wire and advanced until it enters the wall of the acetabulum. It is not necessary

to pierce the inner wall of the pelvis. If this cortical bone is preserved intact, it stabilizes the guide wire.

A nail (Fig. 1, *A*), two to three centimeters shorter than the distance between the outer cortex of the femur and the inner surface of the pelvis, is next driven over the guide wire with the help of the introducer (Fig. 2, *C*) and mallet until the head, neck, and a small part of the body of the nail emerge inside the pelvis sufficiently to provide clearance between the neck of the nail and the oblique inner wall of the pelvis. This is done to permit easy application of the stop-plate.

FIG. 4-A

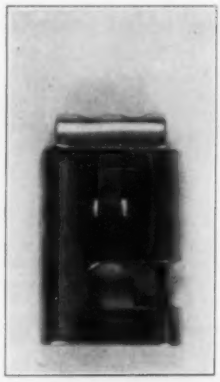

FIG. 4-B

Fig. 4-A: The open stop-plate shows the spring lock in the upper part of the sleeve. When the rider is pulled out, the spring lock prevents the rider from sliding down during application of the sleeve to the neck of the compression nail.

Fig. 4-B: The closed stop-plate shows the rider closing the opening in the sleeve. With the rider in this position, the stop-plate encircles the neck of the nail and is held securely.

FIG. 5-A

Fig. 5-A: The assembled compression apparatus.

Fig. 5-B: The compression apparatus transfixing the hip joint.

FIG. 5-B

The stop-plate consists of a sleeve with a slot in one side and a rider within the sleeve. When the rider is pulled out (Fig. 4-A) the slot is open; when pushed into the sleeve (Fig. 4-B), the slot is converted to a hole the size of the neck of the nail. If the rider is pulled out as far as it can go, it cannot slide down by itself because it is locked in this position by a small spring lock situated in the upper part of the wall of the sleeve (Fig. 4-A). The slot in the stop-plate is slipped on to the neck of the nail with the help of the special right-angled forceps (available in the right and left-handed forms) (Fig. 2, *I*), and the rider is pushed down with a finger or blunt instrument to lock the plate securely to the neck of the nail (Fig. 5-A). With the mallet and nail extractor (Fig. 3, *B*) applied temporarily to

the base of the introducer, as shown in Figure 6, the nail is pulled out until the stop-plate is anchored securely against the inner wall of the pelvis. Owing to the obliquity of that wall, the stop-plate usually makes contact with the bone with only one or two of its edges or with a part of its flat surface (Fig. 5-B). This small area of contact does not interfere with its function and even very strong compression can be applied without danger of the plate cutting through the bone. The brunt of the pressure is borne by the sleeve of the stop-plate since the head of the nail rests against the sleeve without making direct contact with the rider. This tends to compress the rider within the sleeve and to prevent the plate from slipping off the nail *. After the nail has been withdrawn as far as possible, the

FIG. 6

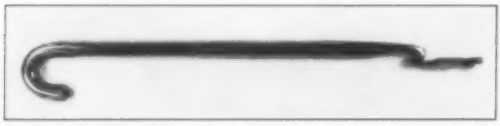

FIG. 7

Fig. 6: The extractor of the compression nail attached to the nail introducer.
Fig. 7: The stop-plate is being opened by the stop-plate extractor.

femoral head is impacted firmly into the acetabulum with the modified (extended) impactor (Fig. 2, *F*) without removing the introducer from the nail, so that the nail may again be retracted after impaction, if necessary. If a nail of proper length has been chosen, the base of the nail should now be located inside the femur two to three centimeters below the lateral cortex. If the nail sticks out beyond the cortex of the femur, no compression can be achieved since the nail will abut against the frame of the compression plate. If the nail is of proper length, the introducer is removed and the square, cannulated compression screw (Fig. 1, *C*) is inserted into the nail with the fingers or with a hollow spanner (Fig. 2, *G*). This procedure is facilitated if the screw is inserted over the guide wire. Once the screw is properly started on the threads of the nail, the guide wire is removed.

The compression plate (Fig. 1, *D*) is next slid over the compression screw until its concave surface lies snugly adjusted against the outer aspect of the cortex of the femur (Fig. 5-B). The square inlet of the compression plate is hinged to allow it to adapt to any angle of inclination of the screw to the femur, from 90 to 160 degrees (Fig. 5-A).

A compression spring (Fig. 1, *E*) is threaded over the screw and placed against the compression plate, followed by a winged lock washer (Fig. 1, *F*) which has a square opening. Twenty-four-kilogram springs are used in patients with hard, sclerotic bone; that is, patients with advanced osteo-arthritis of the hip. Twelve-kilogram springs are used in patients with softer bones; that is, children with

* In earlier cases only the U-shaped rider was used for the fixation of the nail inside the pelvis. In one case the rider slipped off the neck of the nail, thus causing loss of compression.

paralytic hips and osteochondritis dissecans. Finally, a nut (Fig. 1, *G*) is applied and tightened with a hollow spanner (Fig. 2, *H*) until full compression of the spring is achieved and rocking of the limb in all directions does not produce any movement at the joint. Another indication of satisfactory compression and fixation is inability to move the stop-plate against the inner wall of the pelvis when the plate is grasped with an instrument or fingers and rocked.

The wings of the lock washer are bent over the corresponding edges of the nut with the pliers (Fig. 5-A); in that way, a self-locking compression unit is formed. The nut is thus prevented from receding by the wings of the lock washer, which cannot turn because its square hole fits snugly about the square compression screw. The compression screw cannot come out of the nail because it fits into the square opening of the compression plate, which in turn is rendered immobile against the outer cortex of the femur by reason of its concave surface and the force of the compression (Fig. 5-B).

The redundant part of the compression screw is cut off with the heavy-duty bolt cutters.

No plaster-of-Paris immobilization is necessary unless for some reason the fixation is not deemed adequate. After operation, the limb is supported on pillows when the patient is in bed.

If an iliofemoral graft is used, a graft of proper size is cut from the iliac wing and a bed for it is prepared along the upper aspect of the head and neck with slots cut out for the ends of the graft in or just above the acetabular roof and in the greater trochanter before the nut is tightened. After the graft is fitted into its bed, the compression is carried out as previously described, thereby locking the graft securely in place so that no additional internal fixation for the graft is necessary. In the patients in whom iliofemoral grafts were used, the empty spaces between the femoral head and neck, graft, and acetabulum were filled out with bone chips taken from the ilium. When an iliofemoral graft is applied, I feel that weight-bearing on that extremity should not be permitted until two to three months after operation to avoid the risk of fracture or displacement of the graft.

This operation can be carried out through the lateral or posterolateral approach with the addition of a short anterior incision to gain access to the inner wall of the pelvis [5].

The whole operation is performed under direct vision and no roentgenographic control is necessary.

Extraction of the nail has not been necessary except for serious complications, such as protracted infection with chronic draining sinuses. Extraction of the nail may be difficult unless the following points are realized. Within a few months or even weeks after the operation, the stop-plate on the inner wall of the pelvis becomes covered by bone. This bone must be carefully removed. Once this is done, the nail must be advanced a short distance so that the stop-plate may be rotated about the nail into a position which makes it possible to lift the rider with the special instrument designed for the purpose (Figs. 3, *A* and 7). The slot in the sleeve is thus opened, and the sleeve can be slipped off the neck of the nail by grasping it with a clamp.

Excessive bone about the opening in the cortex of the femur must also be removed since this will interfere with the removal of the nail, the base of which is wider than the compression screw. This bone is removed in the following manner: with the heavy-duty bolt cutters, the pins in the hinge of the square inlet of the compression plate are cut so that the compression screw with the inlet of the compression plate, the spring, the winged lock washer, and the nut still on it, may now be removed from inside the nail by turning the screw with a pair of

pliers *. The remaining frame of the compression plate is next removed and the opening in the bone is enlarged with the clearance drill and osteotomes, if necessary. The nail is then extracted with the modified Smith-Petersen extractor (Fig. 3, *D*) or with the nail extractor and hammer (Fig. 3, *B* and *C*). If the apparatus is to be removed because of a painful area over the protruding tip of the compression screw, the protruding portion can be eliminated by the removal of the screw and the plate, leaving the nail and stop-plate undisturbed. This is a minor procedure, and had to be carried out in one patient only [5].

CLINICAL MATERIAL AND INDICATIONS FOR OPERATION

I have been developing the method described since 1954†. Between 1956 and 1960 I operated on fifteen patients, and between 1957 and 1959 Dr. Seidenman of Malben Hospital, Beer Jaacov, operated on another five patients. He was kind enough to assess the results of the operations on his patients for the purpose of this communication.

TABLE I

DIAGNOSIS OF DISEASE BEFORE OPERATION
NINETEEN PATIENTS

Disease	No. of Patients	Age (*Years*)
Osteo-arthritis	8	From 19 to 60
Absence of the head and part or entire neck of the femur	3	From 16 to 65
Paralytic dislocation	4	From 10 to 22
Congenital dislocation *	3	From 13 to 14
Osteochondritis dissecans	1	14
		Age range: From 10 to 65

* Unsuccessful previous treatment

This report is based on the analysis of the results of the operation in nineteen patients who have been followed from one to five years, with an average follow-up of two years and three months. (The last patient was operated upon too recently for this assessment.) There were thirteen female and six male patients. Their ages ranged from ten to sixty-five years, with an average of twenty-nine years for the whole group. In the patients on whom arthrodesis was performed for osteo-arthritis of the hip, the ages ranged from nineteen to sixty years, with an average of 42.2 years.

The main indications for the operation were: intractable pain in the hip or thigh with marked limitation of motion and no improvement with conservative treatment; and instability of the hip (Table I).

COMPLICATIONS

All patients were alive at the time of the follow-up evaluation.

* This step is often necessary as the deformed end of the compression screw (after its section with the heavy-duty bone cutters at the previous operation) may prevent removal of the nut.

† Mr. H. Ulrich, of Ulrich and Co., St. Gallen, Switzerland, was kind enough to construct the first instruments for me in 1954, but it was the enthusiastic and sustained cooperation of Mr. M. Pinkesfeld and Mr. Y. Lefkowicz, of Hamynateach, Tel-Aviv, which made possible the development of the instruments in their present form. Mr. Pinkesfeld was particularly helpful in the development of the self-locking device for compression. Dr. G. Leventhal, of Philadelphia, suggested the use of the winged lock washer, instead of the hexagonal collar used originally. This permitted shortening of the protruding part of the screw.

Wound infection occurred in six patients. In two it was protracted enough to necessitate removal of the whole compression device, including the nail, after both hips were soundly fused. In two other patients secondary suture of the wound was necessary and one of them, a sixty-five-year-old woman with diabetes, finally required a Tiersch graft to close the wound. In the other patient, walking was delayed because of the infection. In the remaining two patients the infection was superficial. Eventually, all wounds healed completely, the longest time of healing being about three months.

There were two main causes for this high incidence of wound sepsis. All these infections occurred between November 1958 and July 1959 at a time when infections with the *Staphylococcus aureus phage-Israel* [6], resistant to all available antibiotics, were common after many operations. The other cause was that the operations during this period were carried out through one incision (the prolonged

FIG. 8

FIG. 9

Fig. 8: A fourteen-year-old boy with osteochondritis dissecans of the head of the femur had had intractable pain and limitation of motion for one year prior to arthrodesis. This roentgenogram, made six months after operation, shows bone trabeculae extending across the joint. Four months previously (two months after operation) the boy fell from his bicycle and fractured the ipsilateral tibia. The patient is now serving as a sailor in the merchant marine.

Fig. 9: A man, thirty-two years old, underwent a second arthrodesis because the first had failed. This roentgenogram, made eleven months after the second procedure, shows bone union in the middle and lower parts of the hip joint. The patient now performs heavy manual labor.

Smith-Petersen incision) which necessitated dissection of tissues over a large area to provide exposure of the lateral aspect of the femur. Since this approach was abandoned and two incisions used for the operation—the Smith-Petersen incision for arthrodesis of the joint and a separate one over the outer aspect of the thigh for the introduction of the nail—there were no infections.

After operation one patient (my second case) had thrombosis of the veins of the leg and paralysis of the femoral nerve, both on the side of operation. Both the thrombosis and the femoral-nerve palsy were probably due to too vigorous retraction of the soft tissues inside the pelvis during the introduction of the nail. The femoral-nerve palsy recovered only partially. In another patient a transient peroneal-nerve palsy occurred.

A long, oblique fracture of the shaft of the femur occurred in one patient in a fall one and a half years after operation. The fracture healed readily in traction.

Another patient fractured the ipsilateral tibia in a fall from a bicycle two months after operation. Despite this, the hip joint remained undisturbed; one month later there was roentgenographic evidence of beginning union; six months after operation, there was sound bone union (Fig. 8).

Reoperations were carried out on six patients from two weeks to thirteen months after arthrodesis of the hip. In the first patient in this series the procedure had to be done over because of loss of compression. When this operation was performed the locking device had not been perfected and the compression screw came out of the nail. Despite the absence of the head and neck of the femur in this patient, the hip fused by bone union after readjustment of the compression device (Fig. 9). In another patient operated on early in 1957 the stop-plate, which at that time consisted of only the rider, slipped off the neck of the compression nail with resultant loss of compression. Another stop-plate of the same kind was

FIG. 10

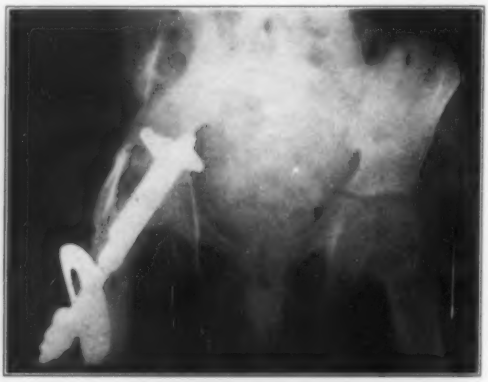

FIG. 11

Fig. 10: A twenty-year-old man had had arthrodesis performed because of painful osteo-arthritis following an old gonococcal infection of the hip. This roentgenogram shows sclerosis of the head and the shortness of the nail. Unsound fibrous ankylosis ensued and the result was classified as *poor*. A longer nail, a spring, and an iliofemoral graft should have been used in the patient.

Fig. 11: A ten-year-old boy had had pathological dislocation of the right hip following poliomyelitis. Operation consisted in arthrodesis with an iliofemoral graft, a nail, 1.4 centimeters in diameter, being used. This roentgenogram, made four months after operation, shows complete bone union. A review of early postoperative roentgenograms revealed a crack in the medial cortex of the femoral neck, which healed uneventfully.

inserted and compression re-established. Solid bony ankylosis resulted. In the remaining four patients second operations were necessary to tighten the nut after loss of compression occurred owing to resorption of bone in the head of the femur. In all four of these patients the device employed was one of the early types which did not have a compression spring. In three of these cases solid bony ankylosis supervened; in the other, the clinical result is satisfactory with roentgenographic evidence of fibrous union. Loss of compression in this manner has not occurred since the compression spring was used (in four cases).

There were no injuries to organs within the pelvis or the abdominal cavity.

EXTERNAL IMMOBILIZATION

Seven of the nineteen patients in this series were immobilized in plaster spicas after operation. Short, single spicas were used in most of these cases and the patients were allowed to walk in their spicas. A few long single spicas were used. The duration of external immobilization ranged from two to four months, the average period being two months and two weeks.

External immobilization was employed on two patients because the femoral head and a portion of the femoral neck were missing and adequate internal fixation could not be achieved. Despite the spicas, non-union developed in both. In two other patients the spicas were used after second operations—one to re-do the arthrodesis, the other to replace the stop-plate after it had slipped off. Both of these operations resulted in bone fusion. In the three remaining patients the spicas were used for the immobilization of corrective femoral osteotomies performed shortly before or after the arthrodesis, one on the same side as the hip arthrodesis, the other two on the opposite side.

TABLE II

CLASSIFICATION OF RESULTS AND RELATIONSHIP TO AGE
NINETEEN PATIENTS

Result	No. of Patients	Age in Decades	No. of Patients	Average Age in Years
Excellent	14			28
		2nd	7	
		3rd	1	
		4th	1	
		5th	1	
		6th	3	
		7th	1	
Good	2			31.5
		2nd	1	
		5th	1	
Poor	3			33.6
		2nd	1	
		3rd	1	
		7th	1	

WEIGHT-BEARING

Partial weight-bearing with crutches was started as soon as the wounds had healed, provided the fixation was stable and other conditions warranted. In the nineteen cases included in the series weight-bearing was begun in two weeks in one patient, in three weeks in another, in four weeks in four, in five weeks in one, in six weeks in two, in eight weeks in four, in twelve weeks in two, and in sixteen weeks in one. The average time for the resumption of weight-bearing was seven weeks after operation. In three of the nineteen cases reported there was no information regarding the time weight-bearing was resumed.

All patients in this series regained a normal range of motion in the knee on the side of the fused hip.

RESULTS

The results of these hip fusions were rated on the basis of the clinical examination and roentgenographic findings as *excellent*, *good*, or *poor* (Table II). Patients in the excellent group had bone fusion as evidenced by roentgenogram (either visible trabeculae extending across the head and acetabulum or obliteration of the joint space) with the hip in neutral or nearly neutral position; they could walk without difficulty (except when handicapped by abnormality of the opposite lower extremity); and had no pain. Fourteen patients were in this group. There were two patients who were considered to have good results. Both had clinically sound union of the hip in neutral position but the roentgenograms revealed that union was not by bone. Both were women. One could walk for long distances,

experiencing only occasional fleeting pain in the thigh; the other had a painless stable hip but walking was limited because of complete dislocation of the opposite hip. In the group with poor results there were three patients; two with obvious non-union of the hip and one with a painful deformed hip and unsound fibrous union (Fig. 10).

Time to Bone Union

Iliofemoral grafts were used in three of nineteen patients. Two were children with paralysis of their hip muscles: one a boy *, ten years old, whose hip was solidly fused, as seen on roentgenograms four months after operation (Fig. 11); the other, a girl *, twelve years old, whose hip showed partial bone union by roentgenogram five months after operation. The third patient was a fifty-year-old woman with osteo-arthritis; roentgenograms showed her hip to be solidly fused nine months after operation.

Of the sixteen patients without iliofemoral grafts one, a fourteen-year-old boy, had roentgenographic evidence of early bone union three months after operation and of full union three months later (Fig. 8). On the other hand, solid fusion did not occur until eighteen months after operation in a woman, fifty-three years old, with osteo-arthritis. All the other hips that fused solidly, did so within one year after operation with the possible exception of one patient, whose earliest available roentgenogram was made fourteen months after operation, at which time there was solid bone fusion.

In Table II the ages of the patients in this series are correlated with the results. The series is too small to permit any conclusions as to the relation of age to the incidence of fusion when this apparatus is used.

Results of the Arthrodesis in Osteo-arthritis of the Hip

In the eight patients suffering from osteo-arthritis of the hip, five hips fused by bone union and two fused by sound fibrous ankylosis. There was one unsound fibrous union in a patient with osteo-arthritis following an old gonococcal infection of the hip joint (Fig. 10). It is of some interest that all five solid bone unions occurred in patients in the fifth, sixth, or seventh decade of life, whereas the unsound fibrous ankylosis and one of the sound fibrous unions occurred in young patients in the third and second decades of life, respectively.

Subjective Classification of Results

Fifteen of the nineteen patients were satisfied and four were dissatisfied. One young man was dissatisfied because of pain and deformity after an unsuccessful fusion for old, gonococcal arthritis of the hip. A woman in her fifties with bilateral subluxated and painful hips had satisfactory fusion of one hip but she refused operation on the opposite hip and therefore had no improvement in function.

Two young Bedouin women, one with solid bone fusion and the other with sound fibrous union, were both unhappy because of their inability to squat. In retrospect, these primitive women should not have been operated on. The advantages and disadvantages of the operation were carefully explained to them before operation but they failed to grasp what the results of hip fusion would be.

DISCUSSION

Experience with the method of arthrodesis described is encouraging although the series is small and no definite conclusions can be drawn as to its value at this time. The relatively high incidence of fusion (84 per cent) in this small

* Standard apparatus was used, except for the nail (1.4 centimeters in diameter).

series, which included elderly patients with osteo-arthritis, suggests that this method has merit. This incidence of fusion is particularly impressive in view of the fact that external immobilization was required in only seven of the nineteen patients and partial weight-bearing was started two to eight weeks after operation in thirteen patients.

In the three hips in which fusion failed to occur, the conditions were decidedly unfavorable. In one there was marked sclerosis of the femoral head and acetabulum after an old gonococcal infection. In retrospect, an iliofemoral graft should have been used in this instance, as well as a longer nail. In the other two failures the head and a large part of the neck were missing: in one, as the result of an old septic arthritis; in the other, as the result of an unsuccessful arthroplasty with a Judet prosthesis. Because of the short distance between the lateral femoral cortex and inner wall of the pelvis very short nails (five centimeters) were used in these hips. These short nails did not provide firm fixation of the deficient bone of the femoral fragment to the acetabulum. External immobilization in the form of plaster spicas was used, but to no avail. This suggests the possibility that plaster casts are relatively ineffective and that with the adequate internal fixation ordinarily obtainable with this device a plaster spica is not necessary, and probably of little, if any, value. In retrospect, it would appear that a long obliquely placed nail combined with an iliofemoral graft might have provided adequate fixation and more osteogenesis for these hips in which the femoral head and a portion of the neck were missing.

The incidence of complications in this small series was too high, but these complications have been reduced to a minimum in the later cases by changes in technique and modifications in the apparatus. The many infections in the earlier cases can be attributed to the technical difficulties encountered in developing the procedure and the use of a single incision with excessive dissection. No infection occurred when two incisions were used. Defects in the apparatus, which were subsequently eliminated, were responsible for six reoperations. Four of these second operations were necessitated by loss of compression associated with bone absorption. The addition of the compression spring has eliminated this difficulty. In the other cases defects in the stop-plate and compression screw resulted in loss of compression. Modifications in design have eliminated these difficulties.

The results to date suggest that the addition of the iliofemoral graft improves the chances of union and may even shorten the time required for solid bone union to take place. With the exception of one, or possibly two, of the hips that united solidly, roentgenographic evidence of bone fusion was present within one year.

All things considered, the method described appears to have certain advantages and the results to date compare favorably with those obtained by other methods, including central dislocation [1,2,4]. Final conclusions regarding the value of this procedure must await increasing experience.

SUMMARY AND CONCLUSIONS

A new method of internal fixation with compression for arthrodesis of the hip joint with a massive three-flanged nail and a self-locking compression device is presented.

The results of nineteen operations carried out on nineteen patients from ten to sixty-five years of age with a follow-up of from one to over five years are presented and discussed. In fourteen patients (74 per cent) there was sound bone fusion; in two others there was sound fibrous union, thus making a total of sixteen patients (84 per cent) with clinically solid fusion.

There was no postoperative mortality in the series. Wound sepsis was the most frequent postoperative complication.

This operation seems to have the following advantages: (1) once the technique is mastered it is not difficult; (2) external immobilization of the hip with plaster casts is seldom necessary; (3) walking may be permitted early (an average of seven weeks after operation); (4) knee exercises may be started immediately after operation; and (5) if union by bone occurs it does so usually within the first postoperative year. If a self-locking iliofemoral graft is applied fusion occurs more rapidly.

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Spondylolisthesis and Tight Hamstrings*

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The posterior femoral muscles—the so-called hamstring muscles—are composed of the biceps femoris, semitendinosus, and semimembranosus. The biceps femoris arises from the tuberosity of the ischium and inserts into the head of the fibula and the lateral condyle of the tibia. The semitendinosus and semimembranosus also arise from the tuberosity of the ischium and insert into the medial and posteromedial aspect, respectively, of the upper part of the tibia.

These hamstring muscles flex the leg on the thigh and also serve to support the pelvis upon the femur in the erect position, resisting flexion of the trunk on the thighs. In the normal person, because of the shortness of these muscles, the hip cannot be flexed completely without first flexing the knee to relax the hamstrings. In our experience, the thigh may usually be flexed approximately 80 degrees in adults and 90 degrees in children with the knee completely extended, but further flexion is prevented by hamstring tightness.

Tightness, spasm, or contracture of the hamstring muscles may often accompany lesions involving the cauda equina. Such lesions include tumors of the cauda equina itself or tumors that encroach upon or compress the cauda equina [1]; a contracted filum terminale [3]; diastematomyelia; a very large protrusion of an intervertebral disc; lesions of the cauda equina caused by trauma; and the more advanced degrees of spondylolisthesis.

The hamstring muscles receive their innervation through the fourth and fifth lumbar and the first, second, and third sacral nerves. The short head of the biceps receives its nerve supply through the common peroneal nerve, and the other muscles in this group are supplied through the tibial nerve. The exact mechanism that produces hamstring-muscle spasm is not clearly understood. In the filum terminale syndrome and in spondylolisthesis of an advanced degree, traction on the cauda equina is thought to produce a reflex spasm of the hamstring muscles [5,9]. Tumors or inflammatory lesions of the cauda equina may also cause sufficient irritation of nerve roots to produce excessively tight hamstrings [8].

The syndrome of spondylolisthesis and tight hamstrings is not a common clinical entity. In the published reports of large series of cases of spondylolisthesis there is no specific reference to the clinical finding of hamstring tightness [2]. Güntz and Schlüter, in a series of 124 cases of spondylolisthesis, found "straining of the ischiocrural musculature" in sixteen patients, but they mentioned no case in which there were excessively tight hamstrings. We wish to present our experience with two cases of severe spondylolisthesis accompanied by excessive tightness of the hamstring muscles.

CASE REPORTS

CASE 1. A twelve-year-old boy was first examined at the Cleveland Clinic on July 27, 1950, because of a peculiar gait. In November 1949, his parents first noticed that the boy was limping on

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FIG. 1-A

FIG. 1-B

Case 1. Anteroposterior (Fig. 1-A) and lateral (Fig. 1-B) roentgenograms of the lumbar spine, made at the time of the patient's initial examination, July 27, 1950. There is a Grade 4 spondylolisthesis of the fifth lumbar on the first sacral vertebra and a slight scoliosis of the lumbar spine.

FIG. 2-A

FIG. 2-B

Case 1. Anteroposterior (Fig. 2-A) and lateral (Fig. 2-B) roentgenograms of the lumbar spine made on June 14, 1954, four years later. The spondylolisthesis remains unchanged, but the scoliosis has increased.

the right. There was no history of an antecedent injury. The limp became progressively more noticeable over the next few months, and the child tended to walk on the toes of the right foot. There was no pain whatsoever in the back or in the legs.

Examination revealed a well nourished boy of average height and development who walked with a most peculiar gait. The pelvis was thrust forward by an excessive tightness of the muscles in the posterior aspect of the thighs. There was a notable lumbar lordosis with a readily palpable shelf deformity at the level of the lumbosacral joint, and a slight scoliosis of the lumbar spine to the left. There was no tenderness over the spine. Motions of the spine when the patient was standing were

FIG. 3-A

FIG. 3-B

Case 1. Anteroposterior (Fig. 3-A) and lateral (Fig. 3-B) roentgenograms of the lumbar spine made on March 15, 1955, nine months after decompressive laminectomy of the fourth and fifth lumbar and first sacral vertebrae. No spine fusion was attempted.

FIG. 4-A

FIG. 4-B

Case 1. Anteroposterior (Fig. 4-A) and lateral (Fig. 4-B) roentgenograms of the lumbar spine made in June 1961, seven years after operation. There is no change in the scoliosis or the spondylolisthesis.

normal except for forward flexion which was virtually absent. Straight-leg raising was restricted to 10 degrees on the left and 30 degrees on the right, but caused no pain. The deep tendon reflexes were normal. There were no sensory changes and no motor weakness in the lower extremities. The right calf muscles were tight; with some forcing, the foot could be brought up just to a right angle with the knee in extension. Roentgenograms of the spine revealed evidence of a Grade 4 spondylolisthesis of the fifth lumbar on the first sacral vertebra, with a scoliosis of the lumbar spine to the left (Figs. 1-A and 1-B).

The child was admitted to the hospital for physical therapy to stretch the hamstrings and to improve his gait. He was fitted with a Bennett type of back brace. A cast was applied to the right leg to hold the foot in dorsiflexion; this cast was removed after six weeks.

During the following year, the boy continued to exhibit severe spasm of the hamstring muscles. He still had no pain referable to the back and the legs, but he walked with the same peculiar gait and was unable to flex his trunk when standing; sitting, however, he could flex his trunk to at least 60 degrees. Lateral flexion to the right and to the left, as well as extension, was normal. There was no spasm of the erector spinae muscles.

In June 1951, the child was readmitted to the hospital. The three hamstring tendons of the right leg were lengthened by Z-plasty; the sciatic nerve was explored from the level of the gluteal crease to the popliteal fossa. This operation was performed with the patient lying prone. The sciatic nerve was found to be extremely taut, even with the hip in full extension. The nerve resembled a bowstring and was more taut than the hamstring muscles prior to the lengthening of these structures.

After operation, a single hip spica cast was applied with the hip flexed 130 degrees and the knee flexed 45 degrees. Subsequently, the knee was extended with turnbuckles in an attempt to stretch the sciatic nerve gradually. After removal of the cast, there was no improvement in straight-leg raising and no improvement in the boy's ability to flex the spine forward in the standing position. No motor or sensory changes were observed in the right lower extremity at any time.

Over the next three years there was some improvement in gait and some increase in the spinal curvature (Figs. 2-A and 2-B). The child still walked with the same peculiar gait, and straight-leg raising was still restricted to only a few degrees bilaterally. He had no pain in the back or in the legs. He was able to flex the trunk forward approximately 20 degrees.

In June 1954, the boy was readmitted to the hospital for total laminectomy of the fourth and fifth lumbar vertebrae. After removal of these two laminae at operation, the cauda equina was seen to be tightly stretched over the superoposterior aspect of the body of the first sacral vertebra. The cauda equina appeared to be flattened as if it had been compressed by the laminae of the fourth and fifth lumbar vertebrae. Removal of these two laminae appeared to provide adequate decompression of the cauda equina. There was no evidence of any intervertebral-disc protrusion or of neoplasm. The laminae of the fifth lumbar vertebra were very loose. After operation there was gradual lessening of the hamstring spasm, and the boy's gait improved remarkably in the following six months. One year after operation, he was able to flex the trunk forward approximately 45 degrees; straight-leg raising could be carried out without pain to 60 degrees on the left and 40 degrees on the right, representing an increase of 50 degrees and 10 degrees, respectively. The Achilles-tendon reflex was diminished on the right. There were no sensory changes or motor weakness in the lower extremities. The scoliosis was unchanged (Figs. 3-A and 3-B). There had been no further displacement of the fifth lumbar vertebra.

It is now nearly seven years since the last operation, and the patient walks normally. He is able to bend forward with free motion of his lumbar spine and bring his finger tips to within six inches of the floor without bending his knees. There is straight-leg raising of 90 degrees on the left and 80 degrees on the right. He notices some stiffness in the back occasionally upon arising in the morning, but he has no discomfort or difficulty in engaging in the activities of a normal eighteen-year-old college student, and the lumbar spine is mobile on examination. However, he does not participate in any college athletics. Roentgenograms of the lumbar spine reveal no change in the scoliosis or in the spondylolisthesis (Figs. 4-A and 4-B).

Case 2. A ten-year-old girl was first examined at the Cleveland Clinic in September 1952. Her parents stated that since March 1952 she had walked in a peculiar fashion, "throwing her left leg outward and walking on her toes". The child said that she had a little discomfort in the left buttock when she walked a great deal, and she also noted some discomfort in the lower part of the back after sitting for a prolonged period. There was no history of previous difficulty of a similar nature. In January 1952, the child had fallen to the ground from a standing position, striking the left buttock; no pain or limp followed this injury.

Results of a general physical examination were entirely normal. Orthopaedic examination revealed that the child walked with the characteristic spastic stiff-hip gait that is due to excessive tightness of the hamstring muscles. She was unable to flex the trunk forward (Fig. 5-A); other motions of the spine were normal. Straight-leg raising was 10 degrees on the left and 15 degrees on the right without pain. There was moderate tenderness over the lumbosacral joint, and a shelf deformity was palpable in this area. The left thigh and calf measured one-half of an inch smaller in circumference than the right; there was no weakness in any of the muscles in the left lower extremity. Tightness of the left calf muscles prevented dorsiflexion of the foot, which could be brought up only to a right angle with the knee extended. The left patellar reflex was hyperactive; the Achilles-tendon reflexes were present and equal. There were no sphincter or sensory disturbances.

Roentgenograms of the lumbar spine showed evidence of a Grade 3 spondylolisthesis of the fifth lumbar on the first sacral vertebra (Figs. 6-A and 6-B). A myelogram showed a deformity in the column of contrast medium attributable to the spondylolisthesis, but no evidence of disc protrusion or of intradural neoplasm (Fig. 6-C). Results of tests of the spinal fluid were within normal limits.

The child was admitted to the hospital for laminectomy and decompression of the cauda equina. The entire laminae of the fifth lumbar vertebra and a portion of the laminae of the first

FIG. 5-A

FIG. 5-B

Fig. 5-A: Case 2. Photograph made before operation showing that the child is unable to flex the trunk forward.

Fig. 5-B: Three years after laminectomy and spine fusion, forward flexion is possible.

FIG. 6-A

FIG. 6-B

FIG. 6-C

Figs. 6-A and 6-B: Case 2. Anteroposterior (Fig. 6-A) and lateral (Fig. 6-B) roentgenograms of the lumbar spine, made on September 15, 1952, at the time of the patient's initial examination. There is a Grade 3 spondylolisthesis of the fifth lumbar on the first sacral vertebra.

Fig. 6-C: A myelogram (lateral view) made at the same time showed a deformity in the column of contrast medium; this was attributed to spondylolisthesis.

sacral vertebra were removed. There was no evidence of a protruded intervertebral disc at the fifth lumbar interspace. The fifth lumbar-nerve roots were not visualized. The first sacral-nerve roots were both stretched tightly over the prominence of the first sacral segment; there appeared to be no difference in the appearance of the left and the right first sacral-nerve roots. The defect from the fourth lumbar to the first sacral vertebra was bridged by three struts of cortical bone removed from the left tibia; cancellous bone was packed at both ends of the grafts. Immediately after the opera-

FIG. 7-A

FIG. 7-B

Case 2. Anteroposterior (Fig. 7-A) and lateral (Fig. 7-B) roentgenograms of the lumbar spine made on August 20, 1955, approximately three years after laminectomy and spine fusion. There is solid fusion from the fourth lumbar to the second sacral vertebra, inclusive.

tion the child was placed in a previously prepared posterior plaster shell, extending from axillae to knees. In ten days, this shell was replaced by a solid cast of similar dimensions. Two months later, this cast was replaced by a plaster body jacket, extending from axillae to groin; and the child was permitted to walk. Six weeks later, this cast was removed and a lumbosacral corset was applied.

One year after operation, the child was walking normally. There was still some tightness of the hamstrings, but straight-leg raising was now present to 65 degrees bilaterally without pain, and there was forward flexion of the trunk of approximately 50 degrees when standing.

Examination three years after operation revealed a normal gait and complete disappearance of the hamstring tightness (Fig. 5-B). Roentgenograms of the lumbar spine showed a solid bridge of bone extending from the fourth lumbar to the first sacral vertebra (Figs. 7-A and 7-B).

It is now almost six years since this child underwent laminectomy and spine fusion. She walks normally; she is able to bend forward with free spine motion above the level of the graft and touch the floor with her finger tips without bending the knees. She has no pain referable to the back or to the legs. She participates in all of the vigorous activities of a senior in high school.

DISCUSSION

Spondylolisthesis, especially in the adolescent child, need not be accompanied by pain in the lower part of the back and legs. Both of our patients were brought to the orthopaedist because of a peculiar gait and because of their inability to bend forward. The gait produced by excessively tight hamstrings is certainly pathognomonic; once seen and recognized, it will never be misdiagnosed. Dr. L. J. Karnosh, the neurologist who first examined the boy reported in Case 1, described the gait as follows: "This boy walks on his tarsal pads and thrusts his pelvis violently forward to overcome posterior muscle spasm". We believe this is a good description of the gait. The excessively tight hamstring muscles keep the pelvis and the trunk tilted backward and do not permit sufficient flexion of the thighs for a normal gait. To pick up something from the floor, the child must squat down beside it, since, even with the knees flexed he cannot flex his back and hips sufficiently to permit him to bend forward and to reach the floor with his hands.

Straight-leg raising (passive flexion of the hip with the knee extended and the patient supine) is almost always restricted to some degree by any irritation of the sciatic nerve or its nerve roots. The restriction, however, is associated with pain in the lower part of the back and along the course of the sciatic nerve. In cases of

spondylolisthesis with tight hamstrings, straight-leg raising is greatly restricted bilaterally without associated pain; and, in order to flex the thigh even a few degrees, it is necessary first to flex the knee to relax the tight hamstring muscles.

We are convinced that excessively tight hamstrings and the associated peculiar gait are not a common accompaniment of spondylolisthesis. With the advent of adolescence and a period of rapid growth in a child with spondylolisthesis, it is easy to assume that the cauda equina might be subjected to a certain amount of stretching. Furthermore, as the degree of spondylolisthesis increases in adolescence, this will cause a greater stretching of the cauda equina [6,7].

From these two cases, we cannot draw firm conclusions as to treatment. However, we are convinced that spondylolisthesis and tight hamstrings produce a typical clinical syndrome and that the appropriate treatment for this syndrome includes decompression of the irritated cauda equina *. Local measures to stretch or to lengthen the tight hamstrings are of no value, even though the patient has little or no back pain. We cannot say with certainty whether a patient with spondylolisthesis and tight hamstrings should have a simple decompressive laminectomy, a spine fusion without excision of the loose laminae, or a combination of laminectomy and spine fusion. It is our impression that laminectomy and spine fusion should give the best long-term result.

We wish to emphasize that tight hamstrings may accompany any irritative lesion involving the cauda equina. Since the child with tight hamstrings is often brought first to the orthopaedist for diagnosis and treatment, the examining physician must certainly perform a careful neurological examination as well as evaluate the musculoskeletal system. Sphincter disturbances and a saddle type of anesthesia will point to the presence of a lesion within the cauda equina. We are reminded that eleven years ago we examined a ten-year-old boy with Grade 2 spondylolisthesis because spine fusion had been recommended at another institution. The presenting symptom was only tightness in the hamstring muscles. Results of neurological examination, including a lumbar puncture and a myelogram, suggested the presence of a tumor of the cauda equina. At the time of laminectomy, a neurofibroma of the filum terminale, approximately two centimeters in diameter, was removed. This child made an uneventful recovery from his operation and the preoperative hamstring tightness disappeared in a few weeks. In another patient, a fifteen-year-old boy with no spondylolisthesis, a similar clinical picture was produced by a massive protrusion of the fifth lumbar intervertebral disc.

SUMMARY

The syndrome of spondylolisthesis and tight hamstrings occurs in adolescent children and is characterized by severe restriction of straight-leg raising, inability to bend the trunk forward, and a peculiar gait. The mechanism that produces the hamstring spasm is not well understood, but certainly hamstring tightness may accompany any irritative lesion of the cauda equina. We have presented detailed reports of two cases of spondylolisthesis and tight hamstrings, which we ourselves treated surgically, and we have knowledge of seven similar cases supplied by five of our colleagues.

* Because of the paucity of published clinical reports about the syndrome of spondylolisthesis and tight hamstrings, we gathered a series of seven additional cases from some of our colleagues; namely, Dr. Theodore H. Vinke, Dr. Anthony F. DePalma, Dr. Judson D. Wilson, Dr. L. L. Wiltse, and Dr. William M. Deyerle. The average age of these seven patients was twelve and a half years. The majority had advanced degrees of spondylolisthesis. Only two had little or no pain. Laminectomy and spine fusion were performed on four patients and spine fusion alone on three. All patients were relieved of back and leg pain, but three (one who had laminectomy and fusion, and two who had fusion without laminectomy) had some residual hamstring tightness.

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DISCUSSION

Dr. Paul C. Williams, Dallas, Texas: Dr. Phalen and Dr. Dickson have presented an interesting theory deserving of further investigation. Are we, however, overlooking a simple weight-bearing factor?

In man, the weight of the trunk is transmitted to the sacral table as a downward and forward shearing force. This force is unable to cause displacement because the inferior pedicles of the fifth lumbar vertebra hook down and behind the superior pedicles of the first sacral vertebra. A break in the continuity of this key lock permits this shearing force to displace the body of the fifth lumbar vertebra and, to a lesser extent, the superimposed spine. This constitutes an immediate and severe demand for a stable skeletal weight-bearing line which, in most cases, can only be established through the posterior structures. Thus, the patient thrusts the upper part of the trunk backward and lifts the back of the pelvis by contracting the erector spinae muscles. This position increases the lumbar lordosis and brings the posterior elements, principally the spinous processes, into contact. Once a posterior skeletal weight-bearing line has been established, barring severe trauma, there will be no further forward displacement. During this effort to establish a posterior weight-bearing line, the ischial tuberosities with their hamstring origin are lifted, and the patient will firmly resist any action which displaces the sacral table backward, such as straight-leg raising.

In the presence of poorly developed posterior structures of the fifth lumbar vertebra, displacement will be severe since the posterior structures of the fourth lumbar vertebra have to settle to the first sacral segment before a skeletal weight-bearing line can be established.

When the sacral table more nearly approaches a horizontal plane, the skeletal weight-bearing line is established through the posterior aspect of the body of the fifth lumbar segment which seats itself directly upon the first sacral table.

My experience has been that tight hamstrings are found in young individuals who are making a desperate attempt to establish a posterior skeletal weight-bearing line.

Combined Fracture of the Base of the Fifth Metatarsal and the Lateral Malleolus

A Report of Five Cases

BY J. R. PEARSON, F.R.C.S., MANCHESTER, ENGLAND

Fracture of the lateral malleolus is a very common injury, and its production by inversion stress on the foot has been well recognized and frequently discussed since Dupuytren described it in 1819. Fracture of the base of the fifth metatarsal, first described in his own foot by Robert Jones in 1902, is also a common inversion injury. The two fractures have never yet been reported to occur simultaneously in the same limb, even though, from my experience, this usually overlooked combination appears to be not uncommon.

TABLE I

Data on Five Patients with Combined Fractures of the Lateral Malleolus and the Base of the Fifth Metatarsal

Age (*Years*)	Sex	History	Weight (*Pounds*)	Height (*Feet*)	Immobilization (*Days*)
70	F	Inversion twist, descending stairs	128	5 6/12	22
56	M	Inversion twist, getting off bus	140	5 8/12	23
57	M	Inversion twist	145	5 9/12	22
73	M	Inversion twist, descending stairs	118	5 3/12	23
60	F	Inversion twist	117	5 6/12	29

In a consecutive series of 290 fractures around the ankle seen in one year, sixty-six occurred in the lateral malleolus below the level of the joint. Roentgenograms of all sixty-six ankles showed the proximal end of the fifth metatarsal, and this was found to be fractured in five patients. All these five patients were over fifty-five years old; their ages ranged from fifty-six to seventy-three years. All gave a history of an inversion stress on the foot; three injuries occurred while the patients were descending stairs, and two injuries occurred while the patients were walking on level ground. Low-heeled shoes were worn by all patients, and no patient was unduly overweight for age and height.

The two women, who were sixty and seventy years of age, respectively, weighed 117 pounds and 128 pounds, respectively, and were both five feet, six inches in height. The three men, fifty-six, fifty-seven, and seventy-three years old, respectively, weighed 140, 145, and 118 pounds, respectively, and were five feet, eight inches, five feet, nine inches, and five feet, three inches in height, respectively (Table I).

FIG. 1

FIG. 2

FIG. 3

Fig. 1: A distal fracture of the lateral malleolus and a transverse fracture of the base of the fifth metatarsal.
Fig. 2: A transverse fracture of the lateral malleolus at the level of the ankle.
Fig. 3: A transverse fracture in the base of the fifth metatarsal, the same foot as in Fig. 2.

FIG. 4

An experimental fracture of the lateral malleolus and the base of the fifth metatarsal produced by an inverting force to the foot. A nail is inserted through the calcaneus and talus, and a clamp grips the fore part of the foot.

The lateral malleolar fractures were located at or below the level of the ankle joint and were transverse or slightly oblique in the more distally placed fractures (Figs. 1 and 2). The fracture of the base of the fifth metatarsal was transverse

FIG. 5-A FIG. 5-B FIG. 5-C

Figs. 5-A through 5-C: Mechanism of production of fractures.

Fig. 5-A: Inversion with foot dorsiflexed produces a fracture of the base of the fifth metatarsal and a transverse fracture of the lateral malleolus.

Fig. 5-B: Inversion with the foot slightly plantar flexed produces a fracture of the base of the fifth metatarsal and the antero-inferior part of the lateral malleolus.

Fig. 5-C: Inversion with the foot in plantar flexion produces only a fracture of the base of the fifth metatarsal.

TABLE II

EXPERIMENTAL PRODUCTION OF FRACTURES OF THE FIFTH METATARSAL AND LATERAL MALLEOLUS

Position of Ankle	Inversion Force Applied (No. of Specimens)	Result
Ankle fully dorsiflexed	5	Fracture of base of fifth metatarsal and transverse fracture of lateral malleolus
Ankle at a right angle	4	Fracture of base of fifth metatarsal and transverse fracture of lateral malleolus
Ankle in few degrees of plantar flexion	4	Fracture of fifth metatarsal and antero-inferior part of lateral malleolus
Ankle in full plantar flexion	5	Fracture of only fifth metatarsal and rupture of anterior talofibular ligament

(Fig. 3) in all cases. None of these fractures was displaced, and there was no evidence of underlying abnormality in any of the affected bones.

Treatment consisted in the application of a padded below-the-knee, plaster-of-Paris walking cast for approximately three weeks. The patients were encouraged to work from the start, and returned to normal activities within fourteen days of the removal of the casts.

On review one year later, there were no complaints of pain, swelling, or limp, and on physical examination no abnormality was found; roentgenograms showed union of all ten fractures.

THE MECHANISM OF THE FRACTURE

Experiments were performed on fresh cadavera to ascertain the mechanism by which these fractures are produced.

Inversion of the foot was produced manually, using a clamp applied to the fore part of the foot and a nail driven vertically through the calcaneus into the talus as levers (Fig. 4).

Before applying the inversion stress, the tendon of the peroneus brevis muscle was dissected and stapled to the shaft of the fibula (Fig. 4). When the staple was inserted, the peroneus brevis tendon was pulled as taut as possible while the foot was held in the neutral inversion-eversion position and the ankle

TABLE III

INVERSION STRESS AFTER SELECTIVE DIVISION OF THE LATERAL LIGAMENTS OF THE ANKLE IN THIRTY EXPERIMENTS

Position of Ankle	Calcaneofibular Ligament Divided (*No. of Specimens*)	Result	Anterior Talofibular Ligament Divided (*No. of Specimens*)	Result
Ankle dorsiflexed	3	No fracture	5	Transverse fracture of lateral malleolus
Ankle at right angle	4	No fracture	4	Transverse fracture of lateral malleolus
Ankle slightly plantar flexed	3	No fracture	4	Antero-inferior fracture of lateral malleolus
Ankle plantar flexed	4	No fracture	3	No fracture

was held in the predetermined position. Under these experimental conditions, an avulsion fracture of the base of the fifth metatarsal was consistently produced in eighteen experiments by an inversion force, regardless of the position of the ankle joint (Table II).

The type of avulsion fracture of the lateral malleolus produced in thirteen experiments varied with the position of the ankle joint. When the inversion stress was applied with the foot dorsiflexed or at a right angle, a transverse fracture of the lateral malleolus was produced at or just below the level of the ankle joint, whereas when the foot was in a few degrees of plantar flexion, the antero-inferior part of the lateral malleolus was fractured (Figs. 5-A and 5-B and Table II).

In the thirty other experiments, inversion stress was applied to the foot with the ankle in different positions and with either the calcaneofibular or the anterior talofibular ligament divided. It was found that the avulsion force that produced the malleolar fracture acted through the calcaneofibular ligament (Table III). With the foot in full plantar flexion, inversion stress in five experiments did not produce a fracture of the lateral malleolus; instead, the anterior talofibular ligament was ruptured in each experiment (Fig. 5-C and Table II).

It would appear from these experiments that an avulsion fracture of the base of the fifth metatarsal alone occurs only when the foot is forcibly inverted while it is in the equinus position. The combined fracture occurs when the foot is forcibly inverted while the ankle is dorsiflexed or at a right angle or slightly plantar flexed.

SUMMARY

Five patients are described with a combined fracture of the lateral malleolus and the base of the fifth metatarsal—a combination not hitherto reported.

The mechanism of production of these double fractures is shown experimentally to consist in forced inversion while the foot is either dorsiflexed or at a right angle or slightly plantar flexed. Forced inversion with the ankle in plantar flexion produces a single fracture of the base of the fifth metatarsal.

NOTE: I am indebted to Mr. D. Ll. Griffiths, Director, University Department of Orthopaedic Surgery, Manchester Royal Infirmary, for inspiration and guidance in this work; to Mr. Robert Roaf, Director of Clinical Studies and Research, The Robert Jones and Agnes Hunt Hospital, Oswestry, for invaluable help; and to Mr. A. B. Watson, Director, Casualty Department, Birmingham General Hospital, for permission to publish his cases.

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Spinal-Cord Tumor—A Cause of Progressive Neurological Changes in Children with Scoliosis

A Report of Three Cases

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A progressive scoliosis in the presence of neurological disorders is well known and often can be explained on the basis of neurological deficit and resultant muscle imbalance. Increasing scoliosis of this type is a frequent finding in developmental defects of the nervous system, Friedreich's ataxia, von Recklinghausen's neurofibromatosis, syringomyelia, and poliomyelitis. Progressive neurological deficit in a patient with established scoliosis is a more difficult problem. The obvious skeletal deformity and the possibility of spinal-cord compression too often lead to orthopaedic attempts at correction of the deformity as a treatment of the neurological deficit without adequate examination to rule out other causes. The following cases are presented to demonstrate that when progressive neurological deficit appears in a patient with scoliosis, the possibility of spinal-cord tumor as either a coincidental lesion or the cause of both scoliosis and neurological loss must be considered.

CASE REPORTS

Case 1 (C.B.). This patient was first admitted to University Hospitals in 1952 at the age of ten years. At the age of seven years, the diagnosis of missed poliomyelitis had been made at another hospital because of the development of weakness of the shoulder muscles. This weakness appeared to improve considerably, but, when the patient was nine years old, right thoracolumbar scoliosis was noted for the first time. Three months before admission, his scoliosis appeared to increase, and some weakness of his lower extremities developed. Shortly before admission to University Hospitals, he had been admitted to another hospital because of weakness of his lower extremities. While there, urinary retention suddenly developed, and he was transferred to University Hospitals.

On this first admission, there was spastic paraparesis of both lower extremities, thought to be caused by a lesion at the twelfth thoracic and first lumbar spinal segments. There was no demonstrable sensory loss. Roentgenograms showed only the right thoracolumbar scoliosis (Fig. 1). A lumbar puncture showed evidence of a complete block; the fluid was xanthochromic, and the protein was 690 milligrams per 100 cubic centimeters. A lumbar myelogram showed a complete block at the level of the first lumbar vertebra. Laminectomy from the eleventh thoracic to the first lumbar vertebra revealed a swollen discolored spinal cord from which old blood was aspirated, but a biopsy of the cord was not obtained. The dura was left open, and the child recovered except for mild weakness of the lower extremities and residual bilateral positive Babinski signs. For two years he did well, with gradual disappearance of the weakness until one week before his second admission in 1954, when severe weakness recurred, and he again had difficulty voiding. On this admission, there were marked sensory loss and motor loss from the level of the sixth thoracic spinal segment distally, with absent deep tendon reflexes in the lower extremities. Repeat myelograms again demonstrated a block of the first lumbar vertebra. Exploratory laminectomy from the eleventh to the seventh thoracic vertebra showed a typical intramedullary-cord tumor, and biopsy revealed a Grade II astrocytoma. After operation the paraparesis was at first more marked, but gradually improved until the patient was slightly better than he was before operation. He was again seen when he was fourteen years of age because of dislocation of the left hip secondary to obliquity of the pelvis. Examination then showed a partial sensory deficit and a loss of motor function consistent with a lesion at the level of the fourth thoracic spinal segment, with marked progression of the scoliosis.

Case 2 (R.V.). This thirteen-year-old white boy was seen by the Neurosurgical Service of

FIG. 1

Case 1 (C.B.). Roentgenogram made after laminectomy showing right thoracolumbar scoliosis. (The roentgenogram made before operation is no longer available.)

University Hospitals in August 1956, with a history of progressive weakness of both lower extremities of from four to six weeks' duration. The patient had first been seen at University Hospitals when he was three years of age for a chief complaint of flexion contractures of the left hip and knee. These contractures had developed after a febrile illness when the patient was eighteen months of age, and had been diagnosed as poliomyelitis with resultant weak left lower extremity and drop-foot. Treatment at that time consisted in fasciotomy of the hip and a wedging cast for correction of the deformities of the knee and ankle. After successful correction he walked with a long brace. When he was six years old, a triple arthrodesis was done at another hospital. He continued to do well until he was eight years old, when a fall was followed by pain and limitation of motion in the lumbar spine. A mild right thoracic scoliosis was first noted at that time. No further difficulty was noted until the boy was ten years old, when, in addition to the left-sided limp, he began limping with the right lower extremity and complained of some pain in the right hip. Roentgenograms revealed a slipped femoral capital epiphysis on the right. This was treated elsewhere by manipulation and plaster immobilization. After removal of the cast, there was some recurrence of the flexion contractures of the left hip, and an increase in the scoliosis was noted. Wedging casts were again applied, with some improvement in the hip contractures, but, during the next three years, he continued to have increasing difficulty with flexion contractures of the hips and knees and generalized lower-extremity weakness. He was able to walk, however, until four weeks prior to his admission to the Neurosurgical Service.

Physical examination on admission showed an obese boy who complained of pain in the lower extremities and back. There was a right thoracolumbar scoliosis with kyphosis (Fig. 2). Neurological examination showed paraparesis below the level of the twelfth thoracic spinal segment, a positive Babinski sign on the left, and no elicitable deep tendon reflexes on the left. There were flexion contractures of both hips and knees, more marked on the left. The entire left limb was shorter and of smaller circumference than the right. There were hypalgesia and hypesthesia from the eighth tho-

FIG. 2

Case 2 (R.V.). Roentgenogram showing mild right thoracolumbar curve before laminectomy.

racic through the second lumbar dermatome on the right and a spotty sensory loss in the second lumbar dermatome and the dermatomes caudal to it on the left. Lumbar puncture revealed a total block; the protein was 5,000 milligrams per 100 cubic centimeters. A myelogram showed a block at the level of the twelfth thoracic and first lumbar vertebrae. Laminectomy from the eighth thoracic through the first lumbar vertebra demonstrated a swollen, discolored cord, biopsy of which revealed a Grade II astrocytoma. No cystic component was discovered. Follow-up two years after operation, despite radiation, showed bilateral complete sensory and motor loss below the sixth thoracic spinal segment. There was no significant increase in the scoliosis during the three-year period.

CASE 3 (H.M.). This sixteen-year-old white boy was first admitted to University Hospitals in October 1958, with a chief complaint of severe scoliosis and pain in the right hip. The history revealed that after a severe febrile illness of unknown origin at the age of ten months, paraplegia and complete bowel and bladder incontinence developed. Motor power slowly returned so that he was walking, although with a limp, by the age of four and one-half years, but he had never achieved full bladder or bowel control. At the age of eight years, bilateral Steindler muscle-stripping procedures and a right triple arthrodesis were done at another hospital. At the age of twelve years, because of continued urinary problems, a transurethral bladder-neck resection was done. At around this age, scoliosis was first noted, but was overshadowed by the development of dislocation of the right hip, associated with decreasing motor power and increasing sensory loss in the extremities. Attempts to correct the dislocation culminated in a shelf procedure in January 1958, when the patient was sixteen years of age. On admission, he had not been able to walk effectively for the preceding two years.

Physical examination on admission showed a marked left thoracolumbar scoliosis and old healed decubitus ulcers on both hips, the sacrum, and both heels. There was marked pelvic obliquity with the right side high (Fig. 3), flexion contractures of both knees and hips, and a suprapubic

FIG. 3

Case 3 (H.M.). Roentgenogram showing severe left thoracolumbar curve and marked pelvic obliquity.

cystostomy with an indwelling catheter. Neurological examination showed spastic paraparesis, more marked on the right, and bilateral positive Babinski signs. In addition, there were hypalgesia and hypesthesia which, on the left, extended caudally from the eighth thoracic dermatome, and, on the right, from the second lumbar dermatome with, in addition, some hypalgesia and hypesthesia involving the tenth thoracic to the second lumbar dermatomes on the right. Lumbar puncture showed only a small amount of fluid, which coagulated; the lumbar myelogram was unsuccessful. A cisternal myelogram, however, revealed a complete block at the fourth thoracic vertebra. Laminectomy from the fourth to the eighth thoracic vertebra revealed an enlarged discolored spinal cord with two small areas of cystic fluid; biopsy showed a Grade II astrocytoma.

After operation, roentgen therapy was given to the spine from the second thoracic through the first lumbar vertebra, with some improvement in function. Because of the severity of the scoliosis and the slow growth of the tumor, correction of the curve was attempted. Partial correction of the curve was obtained in a plaster jacket, and spine fusion was done from the seventh thoracic vertebra to the sacrum.

DISCUSSION

Considering the frequency of scoliosis, there have been surprisingly few reports of cases with concomitant neurological involvement [10]. Most reports in the orthopaedic literature have been of a single case [6,7,8]. The largest series, consisting of forty-one patients, of whom five were personally observed, is that of McKenzie and Dewar, whose article also included a review of the literature to 1949. Kerr noted that there had been a total of forty-eight cases of scoliosis associated with paraplegia reported up to 1953; these included cases of idiopathic and congenital

scoliosis, and spine deformity secondary to disseminated neurofibromatosis in his own case. James, in discussing thirty-three cases of kyphoscoliosis stated that in seventeen patients with severe deformity, paraplegia occurred in five.

The causes of the neurological changes have been explained in various ways. McKenzie and Dewar stated that in the twenty-four patients of their series who had been treated by laminectomy, with the exception of three (bone block, congenital band, and syringomyelia), the cause of paraplegia was the combination of a tightly stretched dura and a sharply angulated spinal canal, the point of maximum pressure by the dura being localized at the angle of the spinal canal. Kleinberg [7] listed six possible causes for the development of paraplegia in a patient with scoliosis: (1) unequal growth of the dura and spinal column; (2) sudden increase in scoliosis; (3) anomalous tight dural band; (4) spur of bone in the neural canal; (5) angulation of the cord; and (6) tightness of the nerve roots. A patient reported by Kleinberg and Kaplan showed severe angulation and rotation of the cord on a spur of bone which had invaded the neural canal and lay against the cord. In four of James's patients with paraplegia, the primary abnormality was shown at operation to be pressure on the spinal cord from an anterior ridge of bone.

In 1947, Hyndman reported spinal-cord compression in idiopathic kyphoscoliosis treated by what he described as "transplantation" of the spinal cord. Schneider, in reporting three cases of kyphoscoliosis similarly treated, suggested that transposition of the spinal cord (this term is also used by James) is a more accurate description of the operation. He also pointed out the importance of knowledge of the normal vascular supply of the cord if cord transposition is undertaken.

The highest incidence of scoliosis with progressive neurological deficit occurred in patients who were from eleven to sixteen years of age, which is the time of the most rapid growth of the spine. Some authors [7,9] thought this growth period to be a major factor in the appearance of neurological change.

In the forty-one cases collected by McKenzie and Dewar, it was impossible, in a number of the cases obtained from the literature, to determine the exact type of scoliosis involved. They believed that most cases were, in fact, congenital scoliosis and that the second largest group was probably idiopathic in the modern sense of the word. In a few cases the scoliosis was probably caused by poliomyelitis, some were associated with rickets, and two were cases of von Recklinghausen's neurofibromatosis developing in bone; this last-mentioned situation also occurred in the case reported by Kerr. The problem of paraplegia developing in the presence of Pott's disease is a separate problem, and is not within the scope of this paper.

The three cases that we have reported, however, differ from those cases of scoliosis described in the preceding paragraph in that the neurological changes are secondary to an intradural, rather than to an extradural, cause. In two of our three cases reported, the degree of curvature of the scoliosis was relatively slight as compared with the sharply angulated curve or severe kyphoscoliosis in which mechanical cord compression has been described. Interpedicular widening, as occasionally seen in patients with intraspinal tumors, was not found, but this widening would be difficult to see in the presence of the rotation associated with the scoliosis. Our three cases, however, point out a triad of symptoms which should raise the suspicion of intradural disease. The triad consists of: (1) history of early, often transient, neurological deficit, most commonly ascribed to poliomyelitis; (2) later, the development of progressive scoliosis, for which the patient presents himself to the orthopaedic surgeon; and (3), still later, the appearance of progressive paraparesis which then is ascribed to mechanical compression of the spinal cord. Our three patients demonstrated this triad and all three had intra-

medullary gliomata of the spinal cord. Boldrey, Adams, and Brown reported on ten cases of progressive neurological deficit in patients with scoliosis. In that series, four patients (Cases 2, 3, 4, and 8) showed this same type of history and showed intramedullary lesions (cervical hydromyelia, cystic lesion of the thoracic cord, and thoracic angioma). One other patient (Case 7) showed a suggestion of the triad and also had a thoracic angioma. Two other patients had intradural pathology (angioma and arachnoiditis) without this type of history. Of the remaining three patients, two had extradural developmental defects, and one had an intracranial tumor. Boldrey and associates also stated that scoliosis may be the earliest sign of disease of the spinal cord and the first sufficiently recognized to cause the patient to go to the physician. This was also emphasized by Ingraham and Matson, who noted the difficulty in recognizing spinal-cord disease in children. They found that often there was little in the history or physical findings to make an early diagnosis of spinal-cord tumor. A symptom such as scoliosis may, in its treatment, actually delay recognition of the underlying neurological cause. The cases described in this report emphasize the necessity for follow-up of children with scoliosis and the need for complete neurological investigation when a progressive neurological deficit appears.

We are not prepared to define the relationship of the intradural tumor (astrocytoma) to the development of the scoliosis in our three cases. It is possible, but does not seem likely, that a tumor existed for periods of ten and fifteen years—that is, the respective periods from onset of neurological symptoms until hospital admission in two of the three patients; it is also possible that the tumors had arisen from congenital glial rests that had earlier shown their presence by neurological symptoms diagnosed as missed poliomyelitis. This, of course, is pure speculation. The important point, however, is that when progressive neurological symptoms are found in the presence of scoliosis, an intradural, as well as an extradural, cause must be sought.

CONCLUSIONS

Three cases of spinal-cord tumor causing progressive neurological changes in children with scoliosis have been presented. In each patient a diagnosis of poliomyelitis had been made in early childhood, and the later neurological changes which appeared had been attributed to the scoliosis. We wish to emphasize the importance of following such cases of presumed poliomyelitis with periodic examinations to rule out other neurological diseases, and, if scoliosis appears, to seek an intradural as well as an extradural cause of progressive neurological symptoms.

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Arthroplasty of the Knee

Experimental and Clinical Experiences

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In previous experiments by one of the authors [7,8,9,10] it was demonstrated that some undifferentiated tissues, under proper functional conditions, differentiate during regeneration by functional adaptation into hyaline cartilage, fibrocartilage, connective tissue, tendon, and elastic tissue. In these previous investigations, techniques were developed by which the organism could be obliged to form new articulations with articular surfaces and a synovial lining. Tissue differentiation after transplantation seemed to be facilitated by the method of transplantation and related to the conditions at the recipient site. It therefore seemed logical to assume that transfer of a tissue to a site where its function would be the same as in its site of origin would provide optimum conditions for the survival and physiological function of the transplant.

It is the purpose of this communication to report our investigations on the transplantation of articular cartilage into joints.

When articular cartilage has been separated from its subchondral bone, it will not reattach. Accordingly, one of us (Pap) suggested that articular cartilage with a thin shell of subchondral cancellous bone attached to it might be suitable for transplantation. To test this thesis we performed transplantations of this type in dogs, using autogenous and homogenous tissue.

AUTOGENOUS TRANSPLANTS

Eighteen autogenous transplants of various types were carried out in nine adult dogs as follows:

In two animals, ovoid pieces of articular cartilage and subchondral bone were removed from both femora in the region of the patellofemoral joint, interchanged, and reimplanted in the opposite knee. These transplants were ten millimeters long and five millimeters wide with an attached layer of cancellous bone not more than five millimeters thick. All four of these transplants did well with good functional results and preservation of the articular cartilage, which was normal to both gross and microscopic examination forty-nine days after transplantation.

In seven dogs, fourteen additional autogenous transplants were interchanged between opposite knees in a similar fashion, except that these grafts were of different sizes, some including part or nearly all of the articular surface (Fig. 1, *I* and *II*); others being wedge-shaped or flat but extending completely across the articular surface (Fig. 1, *III*). Nine of these fourteen transplants were well incorporated and gave good functional results. None of these successful transplants was more than five millimeters thick. Five transplants failed. In one animal, whole articulations (both tibial and femoral articular surfaces) were interchanged. Both of these transplants were disintegrated when the animal was sacrificed seventeen days after operation. In another dog in which the femoral condyles were interchanged, the transplant was incorporated on one side and disintegrated on the other at the time of sacrifice ninety-five days after operation. In a third dog both transplants, which consisted of femoral and tibial articular surfaces, failed because of wound infections.

In all of these experiments, a single condyle appeared to be the largest fragment that could be transplanted successfully.

The animals in which the transplants were successful showed little disturbance of function. They avoided excessive movement of the knees during the first one to three weeks, but then resumed normal activity without evidence of limp. Only one, a rather timid animal, never used its leg. In this instance the anatomical findings at sacrifice, sixty-four days after operation, failed to explain this behavior.

The animals with successful grafts in both knees were sacrificed thirty-five, forty-eight, ninety-four, and 122 days after transplantation. The transplants were examined grossly and microscopically.

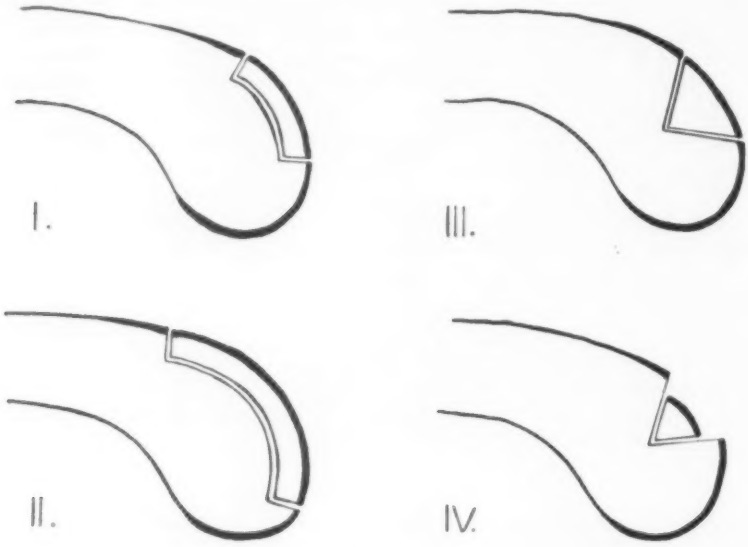

FIG. 1

Schematic drawing of the different types of transplantation used in the animal experiments.

Gross Findings

In all the successful transplants, as early as thirty-five days and as late as 122 days after transplantation, the hyaline cartilage of the transplant did not differ in appearance from the surrounding cartilage and the transplanted cartilage appeared to be organically fused to the surrounding cartilage by tissue grossly resembling cartilage and scar tissue. The underlying subchondral bone was solidly fused in its bed.

Microscopic Findings

The cells in the hyaline cartilage appeared to be viable with no signs of degeneration. The cancellous bone of the transplant showed evidence of new-bone formation and bone resorption. Many of the trabeculae were thickened, consisting of a superficial layer of viable bone and a central zone of dead bone. The superficial layer was two to three cyto-osteones in thickness. (The term *cyto-osteone* as used here refers to a bone cell and the matrix and ground substance formed and maintained by it.) The cells in this superficial layer were obviously viable. Clearly, this layer of bone had been deposited on the surfaces of these thickened trabeculae after transplantation. Beneath this superficial layer of appositional

new bone was necrotic bone with empty lacunae—the original bone of the transplant.

HOMOGENOUS TRANSPLANTS

The dogs used in these experiments were not of the same litter and as far as possible we used dogs of the same size but of different breeds, such as a shaggy-haired sheep dog and a smooth-haired mongrel. Various sizes and shapes of transplants were used, including wedge-shaped pieces (Fig. 1, *III*); pieces consisting of the whole articular surface, with an attached layer of cancellous bone three to five millimeters thick; and large, thick pieces, such as half of a femoral condyle. Transplants of comparable size and shape were interchanged between two dogs.

The wedge-shaped grafts required no fixation. When the whole articular surface was transplanted, an attempt was made to fix the transplanted fragment rigidly with a Vitallium nail. In one instance the margins of the graft were sewed to the surrounding periosteum, but this method was technically difficult. As a rule, the transplants were held in place well by pressure from the overlying patella and patellar ligament.

Thirty-five animals with homogenous transplants were available in these experiments. Twenty-five of the transplants were not more than five millimeters in thickness and not more than six square centimeters in area. All but one of these transplants survived. Ten of the thirty-five transplants were more than five millimeters thick (six to ten millimeters) and included half of a condyle, a whole condyle, or the whole femoral articular surface including all of the condyles. Only three of these transplants survived; a whole condyle is too large to be incorporated.

When a transplant failed it was always apparent within five to eight days after operation. Failure was manifested by evidence of pain in the joint and local signs of inflammation. If the transplant survived as long as ten days, the ultimate functional and anatomical results were good.

It was soon apparent in these experiments that the thickness of the graft must not exceed five millimeters if consistently good results were to be obtained. Thereafter, care was taken that none of the grafts was more than five millimeters thick. In some, especially the larger ones, there were areas where the cancellous bone was only two to three millimeters thick.

Histological examination of these thin areas after transplantation indicated that they were more rapidly incorporated than the thicker areas, but, because one thin transplant fractured while it was being sawed off, we did not use transplants less than three millimeters in thickness.

The animals with homogenous transplants were sacrificed at eight, twelve, sixteen, eighteen, twenty-two, thirty, forty-five, fifty-three, eighty-five, 117, 125, 170, 203, 210, 242, 772, and 879 days after transplantation. Five of these transplants had thus passed the critical period of approximately 180 days (six months) established by Herndon and Chase.

Twenty-three of the twenty-seven successful homogenous transplants were available for gross and microscopic study (Figs. 2-A through 2-D). Four dogs escaped and were lost.

Gross Findings

All of the successful homogenous transplants were found to be firmly attached to the host bone when examined ten or more days after transplantation. On the articular surface, the margins of the transplanted hyaline cartilage were attached to the surrounding host cartilage by a fibrocartilaginous border. In a few areas there was some proliferation of fibrous tissue at the margin of graft, but there was

FIG. 2-A

FIG. 2-B

Figs. 2-A through 2-D: Photographs of the knee joints of dogs at different periods after transplantation.

Fig. 2-A: Seventeen days after homogenous wedge-shaped transplant; note the contours of the graft. Function was good in this dog.

Fig. 2-B: The whole articular surface, not thicker than five millimeters, was transplanted in this dog's knee joint, shown eighty-five days after operation.

FIG. 2-C

FIG. 2-D

Fig. 2-C: Two hundred and twenty-five days after homogenous transplant, the cartilage was perfectly preserved and function was good.

Fig. 2-D: The transplanted cartilage was perfectly preserved and function was very good in the knee joint of this dog 879 days after homogenous transplantation.

no evidence of degeneration of the cartilage (Figs. 2-A through 2-D).

The underlying cancellous bone of the grafts was solidly fused to that of the host. Along the line of fusion, the cancellous bone appeared more dense to gross examination (Fig. 6).

Microscopic Findings

Histological sections were prepared from twenty-two transplants eight to 772 days after transplantation. The oldest transplant in the series, 879 days after transplantation, was preserved as a gross anatomical specimen. Tissue for histological study was fixed in formalin, decalcified in 5 per cent nitric acid, embedded in paraffin, and stained with hematoxylin and eosin, azan, and van Gieson's stain. Histochemical stains (Hale, Hotchkiss, and Ritter-Oleson) were employed for the demonstration of mucopolysaccharides. Ground sections were also prepared by the method of Ruppricht.

In all of the transplants that had been subjected to physiological function, the transplanted cartilage appeared to be living and healthy when examined at intervals ranging from eight days to more than two years after transplantation.

Invariably, the cartilage cells and intercellular substance appeared to be nor-

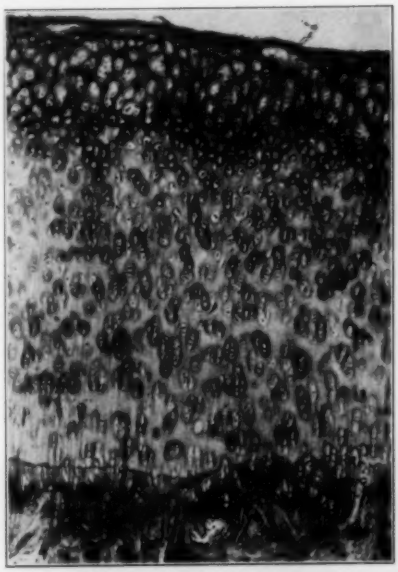

Fig. 3: Microscopic section of the articular cartilage of the dog in Fig. 2-A, eighty-five days after transplantation, showing living, sound tissue. Simultaneous staining of neutral and acid mucopolysaccharides, showing, histochemically, the territorial pattern of chondrons, was done according to the method of Ritter and Oleson (× 150).

FIG. 3

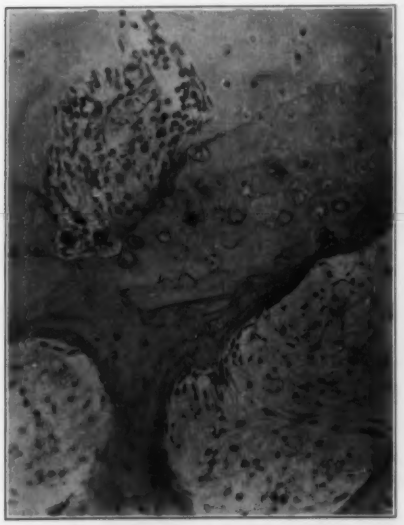

FIG. 4-A

FIG. 4-B

Fig. 4-A: The marrow, bone, calcified cartilage, and cartilage border 117 days after transplantation (hematoxylin and eosin, × 88).

Fig. 4-B: Higher-power view of the marginal part of the articular cartilage (hematoxylin and eosin, × 400).

mal in both the histological and the histochemical preparations (Figs. 3 through 5).

At the margins of the articular cartilage of the transplant there was a border of proliferated tissue which resembled fibrocartilage. Occasionally, at the line of contact between the hyaline cartilage of the transplant and that of the host, there were circumscribed, moderate accumulations of fibroblasts and inflammatory cells. None of these accumulations caused destruction of the transplant.

There was no indication that the bone cells in the transplanted cancellous bone survived. However, this cancellous bone did not act purely as a foreign body, for when it was subjected to physiological function it was not immediately absorbed but was surrounded by host bone and obviously served as a template on which the host bone was deposited in a physiological fashion.

In the marrow spaces of the graft, the marrow cells disintegrated completely

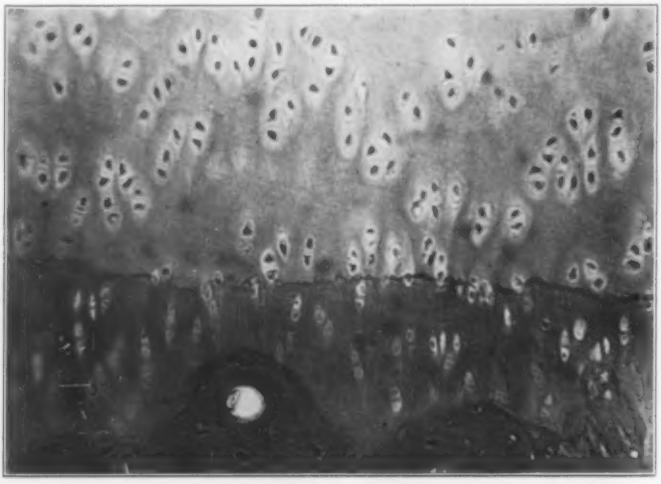

FIG. 5

The articular cartilage of a homogenous transplant 772 days after transplantation (× 214).

FIG. 6

Eighteen days after homogenous transplant, osseous fusion of the host and graft is already in progress (× 7).

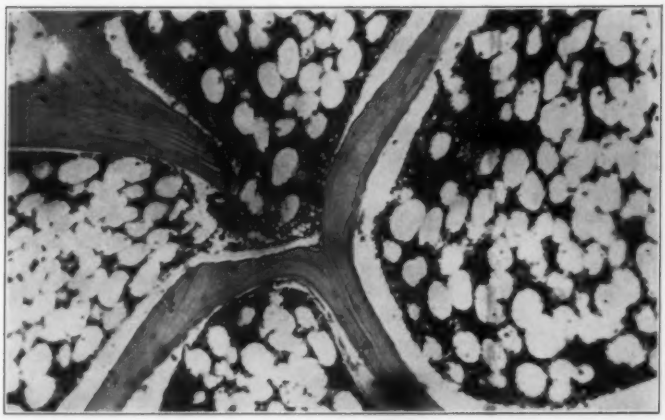

FIG. 7-A

The original thickness of the bone trabeculae of the host.

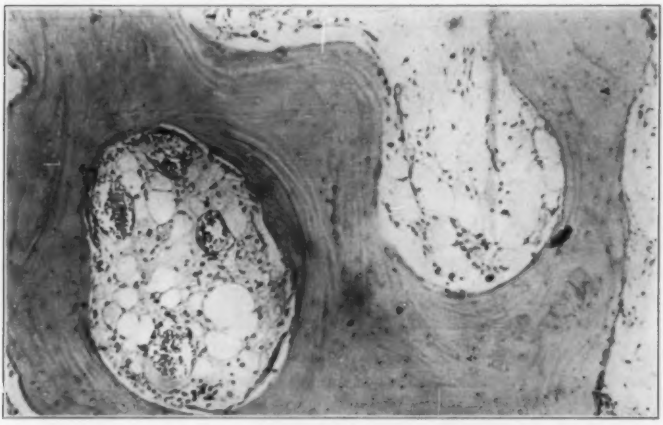

FIG. 7-B

Bone trabeculae of the graft 170 days after the homogenous transplant, showing the thickened trabeculae. Both sections are from the same animal and are similarly magnified (× 110).

within the first few days after transplantation. Then, near the margins of the graft, granulation tissue began to grow in from the marrow spaces of the host. This granulation tissue with its accompanying capillaries gradually filled the marrow spaces of the graft as the necrotic debris of the old marrow was removed by macrophages. Appositional bone formation on the trabeculae of the transplant was observed near the periphery of the graft as early as eight days after transplantation. Here, the trabeculae of the host and of the transplant became fused to each other by new appositional bone (Fig. 6). New bone advanced into the graft from the periphery about one millimeter behind the leading or pioneer cells of the ingrowing granulation tissue.

Twenty-two days after transplant of a five-millimeter-thick graft, all save a small portion of the transplanted bone had been invaded by granulation tissue. At thirty days the whole graft was populated by granulation tissue; subsequently, at fifty-three, eighty-five, and 117 days, the trabeculae of the graft became thickened by appositional bone growth in a fashion similar to that observed in the autog-

enous grafts (Figs. 7-A, 7-B, and 8). In more than twelve of the transplants examined this process of appositional bone growth, as well as osteoclastic bone resorption, was observed. Clearly, the graft bone served as a scaffolding on which new bone was formed but, more than this, resorption and remodeling of these trabeculae, as well as the formation of Volkmann's canals, occurred as further evidence of functional adaptation. In this fashion the amount of non-viable bone was decreased by resorption and replacement.

There was no evidence in either the paraffin-embedded sections or in the ground sections that the bone cells of the transplant survived. However, we could not exclude the possibility that a few cells near the periphery of the graft survived. By the eighth day a large mass of granulation tissue, obviously derived from the

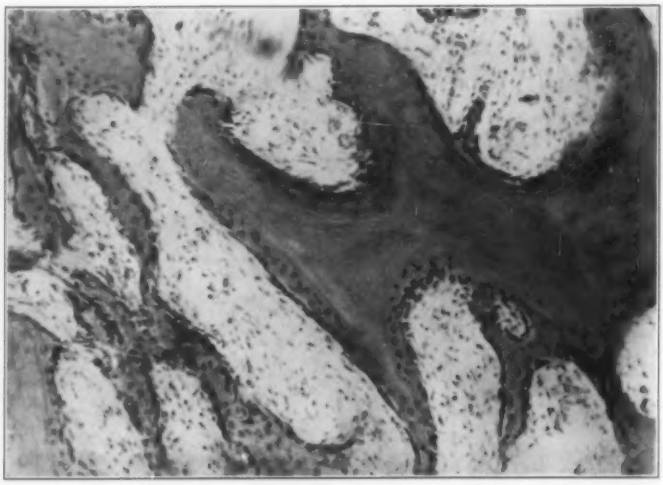

FIG. 8

Fifty-three days after homogenous transplant, the bone trabeculae of the graft are thickened in a manner similar to that observed in viable bone that is undergoing hypertrophy in response to increased activity. The non-living transplanted bone trabeculae are surrounded by newly formed, living bone tissue (van Gieson, × 96).

host, was present at the periphery of the graft, whereas in the central portion all the cells were dead. As early as the eighth day, living osteoblasts appeared on the surfaces of the trabeculae near the periphery; in the central portion of the transplant, however, they did not appear until the thirtieth day after this region had been invaded by granulation tissue. The osteoblasts responsible for the appositional bone were clearly derived from the host.

The marrow of the transplant did not survive. During the first twenty-two to thirty days it was replaced by granulation tissue containing lipoid-laden macrophages. Subsequently, the marrow spaces were filled with normal marrow elements. At fifty-three (Fig. 8), 117 (Fig. 4-B), and 170 (Fig. 7-B) days the marrow elements of the transplant appeared to be normal.

EXPERIMENTS ON THE ROLE OF FUNCTION

To explore further the role of physiological function in the survival of a transplant the following experiments were performed:

First, a wedge-shaped piece of autogenous hyaline cartilage and attached cancellous bone, comparable in size and shape with the transplants already de-

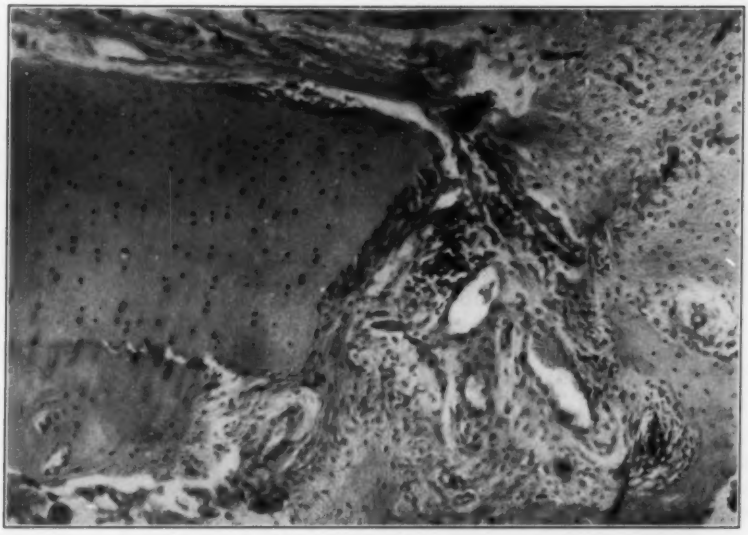

FIG. 9

Margin of articular surface of a homogenous transplant which was countersunk below the level of the articular surface of the host. In the absence of function, the bone, calcified cartilage, and even the articular cartilage are being absorbed seventy days after transplantation (hematoxylin and eosin, × 98).

scribed, was implanted in the gluteal muscle of a dog. When this was removed, forty-five days later, advanced resorption of both the bone and the cartilage was found. Microscopically, there was osteoclastic resorption of the bone near the periphery and some appositional new-bone formation near the center. The hyaline cartilage was being replaced by fibrous tissue.

In another experiment, wedge-shaped grafts of bone and cartilage were transplanted from one knee to the gluteal muscle of each of three dogs, as an autogenous transplant. A similar wedge-shaped homogenous transplant from another dog was then implanted in each of the defects in the knee created by the previous autogenous transplant to the muscle. The autografts that had no physiological, functional stimulus underwent resorption, whereas the functioning homogenous transplants were found on histological examination to be incorporated as previously described. Thus, function, rather than tissue compatibility, appeared to be of greater importance in the survival of the graft.

In six homogenous transplants in the knees of dogs, the influence of environmental factors on the survival of the implant was investigated. These experiments were undertaken because it was suggested that the presence of muscle about the implant, rather than the lack of function, was responsible for the absorption of the grafts in the previous experiments. In these six transplants, wedge-shaped pieces of articular cartilage and underlying bone were transplanted from one dog to another in such a way that the cartilaginous surface of the graft was countersunk beneath the articular surface of the surrounding host joint surface (Fig. 1, *IV*). By forcing the wedge-shaped graft into the defect with moderate pressure, adequate fixation was achieved. None of these grafts became displaced. In this position these grafts did not receive any functional stimuli.

All six grafts were examined microscopically; four at forty-five days, and two at seventy days. All six transplants showed progressive resorption of bone and cartilage (Fig. 9).

Since bones are normally surrounded by muscle it seems reasonable to conclude from these experiments that lack of functional stimuli, rather than differences in environment, was primarily responsible for the absorption of the autogenous implants in muscle and of the homogenous, countersunk implants in the knee joint.

DISCUSSION

From our experiments it was apparent that in grafts of appropriate size and thickness that were subjected to physiological stimuli, the cartilage survived, whereas the cancellous bone and marrow did not. The marrow was replaced first by granulation tissue and then by marrow elements from the host. The bone trabeculae of the implant acted as a scaffolding, first being surrounded by new bone from the host and subsequently being remodeled according to functional requirements.

The importance of function in the survival of various types of tissue transplants was demonstrated and reviewed by Krompecher and Lelkes; many other authors [14], however, considered tissue incompatibility as the chief cause of failure in the transplantation of homogenous implants. In most experiments designed to determine whether the host will tolerate a transplanted tissue, grafts have been placed under the skin, in muscle, or in the peritoneal cavity of the host [14,18]. In the light of our experiments we believe that transplants in these sites, without any functional stimuli, give no decisive information regarding the acceptance or rejection of these implants by the host. It would appear that a transplant is not exempt from the general biological rule that the organism maintains a functioning organ but tends to absorb and eliminate any organ that ceases to function.

Both Dempster and Medawar said that all homogenous transplants except cornea, cartilage, and blood vessels disintegrate sooner or later. As regards cartilage, in 1955, Peer summarized the existent knowledge concerning the transplantation of homogenous cartilage.

The results of the experiments reported here show some progress, at least from a practical viewpoint, in the transplantation of cancellous bone. Although the cancellous bone did not survive it was functionally and biologically accepted by the host since the transplanted trabeculae were first surrounded by new bone of the host and then gradually resorbed and transformed in a physiological manner comparable with the changes going on in other sites in the organism. In other words, within certain limits established by the size of the transplant, it is possible to reconstruct an injured bone with a homogenous transplant and thus restore function.

Altmann demonstrated in rats that transplanted homogenous compact bone previously boiled for ten minutes is not resorbed by osteoclastic activity but behaves grossly like living bone when it is placed so that it has skeletal function. Under these circumstances new viable bone from the host is formed on the surface of the graft as if in response to stress. Lacroix and Judet and Judet observed that after transplantation of homogenous bone, the bone of the host creeps along the graft surface replacing the graft bone. Weinmann and Sicher pointed out that replacement by new bone follows osteoclastic resorption of the old bone and that "creeping replacement" (in the sense that newly formed bone is responsible for the renewal of the old bone) does not occur. From our experiments it would appear that when a graft has skeletal function, resorption is accompanied by appositional new-bone formation, whereas without function, there is no appositional new-bone formation, and total resorption of the graft ensues.

Of particular interest in connection with our experiment is the work of

Herndon and Chase. They transplanted complete articulations in 129 dogs, of which fifty-six survived. All the transplanted joints functioned, but all disintegrated within six months (in the tibia) and nine months (in the femur) after transplantation. Our results were similar to theirs when the transplants were more than five millimeters in thickness. Our better results, which were obtained when the grafts were no more than five millimeters in thickness, are explained, we think, by the fact that there appears to be a critical thickness which cannot be exceeded without degeneration of the graft taking place. At the same time, the layer of spongy bone on the cartilage graft must not be too thin (less than two to three millimeters) since the articular cartilage will then lack adequate support and the graft may be broken while it is being prepared, or the irregular thickness of the underlying cancellous bone may cause certain areas of the articular cartilage to be overloaded and thus damaged.

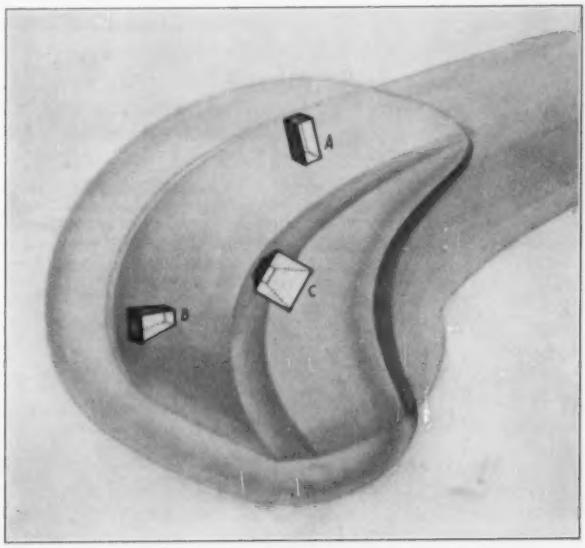

FIG. 10

Diagram showing the influence of the shape of the articular surface of the transplant to be nourished per unit area of undersurface: where the surface is flat, *A;* where the area is convex in one plane, *B;* and where the surface is convex in two planes, *C*. Note the increase in surface area and volume of the transplant per unit area of undersurface caused by the increasing convexity of the surface (see text).

The shape of the graft probably influences the result to a considerable degree, since the area of exposed surface and volume of the graft per unit area of undersurface will vary markedly with the shape of the graft. For example, when the surface of a transplant, four or five millimeters thick, is flat, four or five cubic millimeters of transplant and one square millimeter of exposed surface will have to be nourished through one square millimeter of undersurface (Fig. 10, *A*). When the surface of the graft is convex in one plane, the surface area and volume to be nourished through one square millimeter of undersurface will be considerably larger (Fig. 10, *B*) and, by the same token, when the surface is convex in two planes, the surface area and volume to be nourished will be still larger (Fig. 10, *C*). Thus, when the articular surface of a transplant is convex in two planes and the two radii of curvature are short, the undersurface of the transplant will be too

small in relation to the volume and surface area of the graft for adequate revascularization of the transplanted tissue to occur.

During the last six years homogenous transplants of articular cartilage and cancellous bone, comparable with those described in animals, were performed in eight patients (in elbow, hip, and knee), ranging in age from thirteen to twenty-five years. The transplants were obtained from patients with poliomyelitis on whom arthrodesis of the knee was performed to stabilize a paralyzed extremity. The joint reconstructions—the homogenous transplant in the recipient and the arthrodesis in the donor—were performed concurrently. In these cases, the transplants consisted of small grafts to repair localized defects, so-called mosaic grafts, as well as transplants of the whole articular surface.

Too few procedures were done and the follow-up on most patients is too short to justify reporting these cases at this time. However, the functional results have been encouraging and follow-up roentgenograms suggest that the

FIG. 11-A

Figs. 11-A through 11-D: A woman, twenty-one years old when seen by us, had had tuberculosis of the knee when she was a child, which left her with a flexion deformity. Prior to coming to our clinic she had had a corrective osteotomy in the proximal part of the tibia. A second osteotomy, to correct the angulation of the tibia resulting from the old osteotomy, was done at our clinic, and when this had healed, arthroplasty of the knee was performed. The damaged articular cartilage was replaced by a large graft from the whole femoral condyle of another woman, who had had arthrodesis of the knee performed because of paralysis due to poliomyelitis.

Fig. 11-A: Whole ankylosis of the patella and fibrous ankylosis between the femur and tibia. The para-articular osteotomies on the proximal and distal metaphyses are healed.

FIG. 11-B

Whole bone-shell cartilage from the femoral condyle of the donor. Sawing must be done with a thin (three to four millimeters) saw, slowly and gently, especially at the greater curvatures. Fixation was accomplished with U-shaped Vitallium wires.

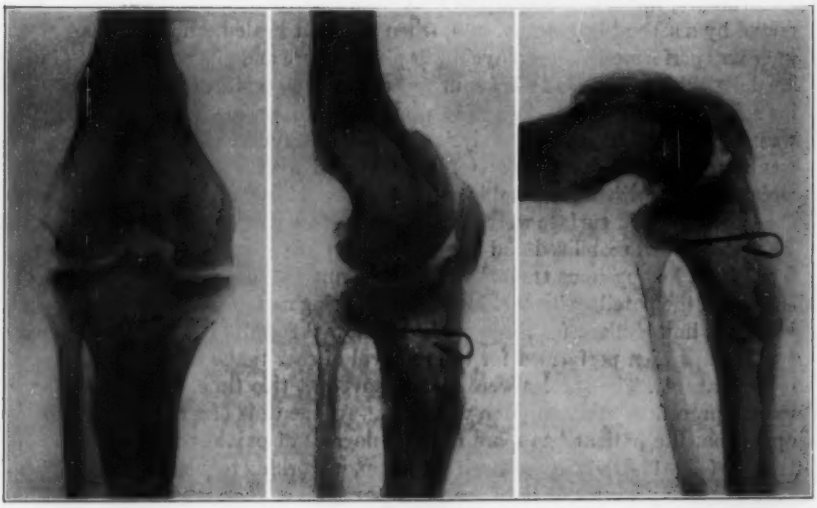

FIG. 11-C

Three years after arthroplasty with bone-shell cartilage. All wires except one have been removed. The range of painless motion was from 90 to 180 degrees. The bone-shell cartilage survived where it was subjected to function and weight-bearing. Degenerative changes can be seen in the proximal part of the transplant, where sufficient function was lacking because the patella did not reach it.

FIG. 11-D

The patient six years after operation.

cartilage has remained viable and the underlying bone has been reconstructed.

On the basis of our present experience we are encouraged to continue to perform this procedure. As a matter of interest we would like to cite one case, that of a woman, twenty-one years old, who had tuberculosis of the knee as a child. The disease had healed with a flexion deformity and, prior to coming to our clinic, she had had a corrective osteotomy in the proximal part of the tibia (Fig. 11-A). When she consulted us she was most anxious to have a mobile knee at any cost.

Accordingly, the angulation of the tibia resulting from the old osteotomy was corrected by a second osteotomy, and, when this had healed, an arthroplasty of the knee was performed. Streptomycin was given before and after operation. The damaged articular cartilage of the femur was replaced by a graft from the whole articular surface of the femur of another woman, on whom an arthrodesis of the knee was performed because of paralysis due to poliomyelitis. The transplant, which was four millimeters in thickness, was removed with a saw and fixed on the recipient's knee with three Vitallium staples (Fig. 11-B). Minor cartilage defects in the tibial articular surface were replaced with mosaic grafts from the donor's tibia. The patella was mobilized and its posterior surface shaped to conform to the surface of the homogenous transplant. No attempt was made to cover the posterior surface of the patella with cartilage or interposing membrane. After operation, the knee was immobilized for three weeks to allow the grafts to adhere. A second operation was then performed for the removal of scar tissue from the anterior part of the capsule. The staples were also removed at this time. Four days after this second procedure active motion was begun. At the time of writing, six years after operation, the patient has more than 90 degrees of painless motion with full extension (Fig. 11-D). She walks with no limp, is working regularly, and is now married. Roentgenograms of the knee made three, five, and six years after operation suggested that the transplant survived. Only in the areas where the cartilage did not participate in the function of the joint, as for example, along the superior surface of the graft where the patella did not reach during extension, did any absorption occur (Fig. 11-C). This observation seems to support the thesis that *function is necessary to maintain the viability of an implant.*

SUMMARY

Autogenous and homogenous transplants of articular cartilage and cancellous bone were performed on the knees of dogs. If the transplants did not exceed five millimeters in thickness and if they were subjected to physiological function, the *transplanted articular cartilage, both autogenous and homogenous, was still viable* 772 days after transplantation, as shown by gross and microscopic examination.

The cancellous bone in both types of transplant did not survive, but was subsequently gradually resorbed and replaced in a physiological manner by new appositional bone surrounding the transplanted bone without evidence of foreign-body reaction. In the cases examined it was clear that the host accepted the nonliving bone trabeculae as a template surrounding the trabeculae with a layer of living bone, thus ensuring acceptance of the transplanted bone. The transplanted marrow died and was replaced first, by granulation tissue, and then, by marrow cells from the host.

Autogenous transplants of similar grafts to muscle and homogenous transplants to the knee with the graft countersunk below the joint surface were absorbed, thus indicating the importance of function in the survival of transplanted tissue.

Similar transplants in human beings have shown rather encouraging results but too few cases have been followed long enough to justify reporting these now.

It is concluded that the thickness of the transplant is critical and that unless the implant is subjected to the stimuli of normal physiological function it will not survive.

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Stress Fracture of the Pelvis During Pregnancy

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Despite the severe stresses that are applied to the skeletal system during the terminal months of pregnancy and during delivery, fractures of the pelvis are rare. In a perusal of the orthopaedic, traumatic, and obstetrical literature in the last ten years, no case report was found in which the pubis was fractured as a result of pregnancy.

CASE HISTORY

A white primipara, thirty-seven years old, delivered a six-pound, three-ounce full-term baby by Cesarean section on March 19, 1960. Presentation was breech. The progress of the mother and the baby after delivery was uneventful.

The pregnancy was normal except that four weeks prior to delivery, while walking in her home, the patient felt a pain in the left perineal area. She attributed the pain to a kick of the child and

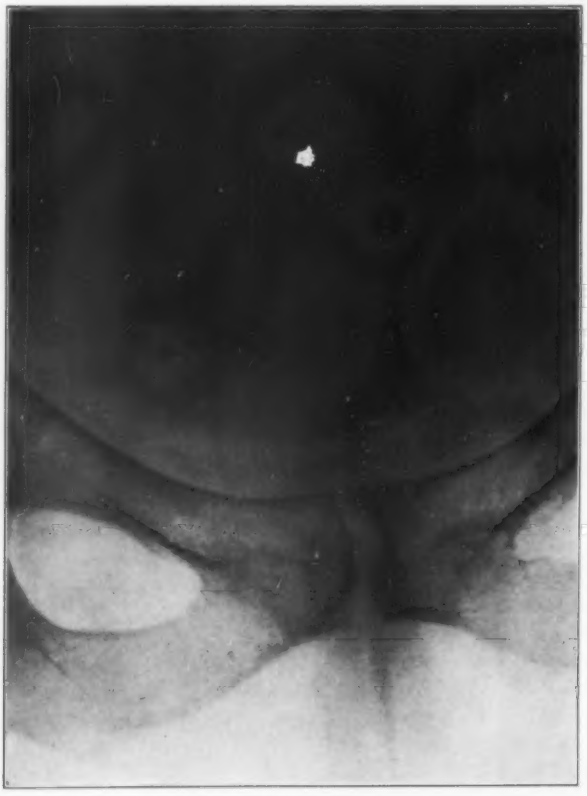

FIG. 1

Roentgenogram made during pregnancy, showing linear fracture of the left superior ramus of the pubis; the fetus is in breech presentation.

FIG. 2

FIG. 3

Fig. 2: Roentgenogram made shortly after delivery, showing absorption at the fracture site.
Fig. 3: Roentgenogram made seven weeks after delivery, showing progressive healing of the so-called fatigue fracture.

FIG. 4

Roentgenogram made about one year after fracture, showing complete healing.

continued to go about her activities. During the next five days the pain increased so much so that she could not walk or stand. Sitting and lying down were also painful. She then went to her obstetrician who noted marked tenderness in the left pubic area on palpation and advised a roentgenogram. As seen in Figure 1, this showed a possible fracture through the medial portion of the superior ramus of the left pubis, parallel and about one inch lateral to the symphysis pubis. During the next month the patient had to be carried because weight-bearing was extremely painful.

There had been no trauma associated with the pregnancy.

After delivery by Cesarean section the patient experienced immediate relief of the pubic pain and was able to walk without difficulty. At this time palpation of the left pubis again showed an area of tenderness. A roentgenogram showed a definite stress-type vertical fracture through the medial portion of the left superior pubic ramus (Fig. 2).

Six weeks later, the patient had no pain but had some slight tenderness over the site of the fracture. Since delivery she had had some discomfort while scrubbing floors, but no significant pain. She was wearing a conventional corset and was able to walk without any difficulty and to take care of

her household duties. A roentgenogram made seven weeks after delivery showed healing of the fracture with very little callus production compatible with the so-called fatigue fracture (Fig. 3).

Roentgenograms made about one year after the fracture on January 30, 1961, showed complete healing of the fracture (Fig. 4).

Blood chemistries, blood count, urinalysis, as well as the ability to concentrate urine, were within normal limits. Roentgenograms of the lumbar spine were negative for any pathological lesion of bone and showed no osteoporosis.

Serum studies were as follows: calcium, 4.5 milliequivalents; phosphorus, 2.0 milliequivalents; total protein, 6.8 grams; and alkaline phosphatase, 4.5 Bodansky units.

DISCUSSION

Selakovich and Love reported five cases of stress fractures of the inferior ramus of the pubis in military personnel in their third decade of life. These fractures may have resulted from stress on the inferior ramus caused by contraction of the adductor muscles in individuals not conditioned to the vigorous activity of basic training.

In the present case the fracture line extended vertically throughout the length of the medial portion of the superior ramus. It seems unlikely that muscle pull would have caused a fracture at this location. Perhaps the eccentric position of the breech presentation and pressure against the left pubis from within could account for this fracture of the pelvic ring. It is worthy of note that the mother was relatively elderly for a primapara. Perhaps the ligamentous relaxation, hormonal mechanisms, and skeletal pliability are less effective at this age.

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The Pathology and Treatment of Radial Subluxation of the Thumb with Ulnar Displacement of the Head of the First Metacarpal

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Radial subluxation of the thumb with ulnar displacement of the head of the first metacarpal is occasionally observed. It is usually associated with a history of initial trauma, followed by gradual development of the deformity. It may appear after continuous or repeated forceful use of the thumb and index finger with pressure applied to the ulnar side of the thumb, as observed in certain occupations. The gradual development of this subluxation was reported in the British literature in gamekeepers who habitually destroy rabbits by forceful twisting of the rabbit's neck between the index finger and thumb. The strain on the metacarpophalangeal joint of the thumb produced by this action was considered to be responsible for the gradual development of the radial subluxation of the thumb with ulnar displacement of the head of the first metacarpal. This deformity was described as gamekeeper's thumb [2]; it is also known as pollex valgus [5].

FIG. 1

Right hand of patient L.B. after the first (unsuccessful) operation, showing displacement of the metacarpal head.

A typical subluxation presents several characteristics. When the hand is at rest, the head of the first metacarpal protrudes to the ulnar side of the metacarpophalangeal joint. It appears somewhat similar to a bunion of a hallux valgus of the foot, although situated on the opposite side of the digit; the protruding head is tender to touch. The thumb itself is displaced in a radial direction (Fig. 1). An attempt to hold an object between the adducted thumb and the index finger produces pain and ulnar displacement of the metacarpal head, with dislocation of the thumb radially, slight flexion of the distal phalanx, and inability to extend the distal phalanx completely.

Roentgenograms show a typical ulnar dislocation of the metacarpal head, especially if slight radial pressure is applied to the ulnar side of the proximal phalanx of the thumb when the roentgenogram is made (Figs. 2 and 3).

Subluxation of the thumb has been considered to be caused by a sudden or gradual disruption of the ulnar collateral ligament of the metacarpophalangeal joint [1]. On this assumption, methods for the correction of this painful and disabling deformity were proposed. They consisted mostly in reconstruction of the collateral ligament on the ulnar side of the metacarpophalangeal joint of the thumb. In accordance with this interpretation of the mechanism of the subluxation, a typical case [4] was treated at the Hospital for Joint Diseases. A meticulous reconstruction of the ulnar side of the metacarpophalangeal joint was performed (C.M. 596334). However, despite proper technique and prolonged postoperative immobilization for eight weeks, the deformity recurred.

FIG. 2

FIG. 3

Fig. 2: Typical roentgenogram of a radial subluxation of the metacarpophalangeal joint of the thumb.

Fig. 3: Extreme dislocation of the metacarpophalangeal joint of the thumb. (Reproduced with permission of the Bulletin of the Hospital for Joint Diseases, **21**: 217–228, 1960.)

In a similar case, a patient (L.B.) with a history of an automobile accident in which the thumb struck the dashboard of the car, a typical subluxation of the thumb gradually developed and was treated by a similar operation. An attempt was made to reconstruct the ulnar collateral ligament. The thumb was immobilized in a plaster-of-Paris cast for three months, but on removal of the cast, the subluxation recurred [3].

In view of the recurrence of the dislocation after what was considered proper operative intervention based on the suggested mechanism, the factors responsible for failure of treatment were investigated.

An experimental study was made on five cadavera. The results obtained were reported previously [4]. This study established that forceful radial deviation of the thumb did not rupture the ulnar collateral ligament of the metacarpophalangeal joint. Instead, disruption of the dorsal apparatus occurred between the tendon of the extensor pollicis longus and the tendon of the adductor pollicis at the articular line. The extensor pollicis longus tendon became displaced to the radial side of the head of the first metacarpal. The metacarpal head protruded through the dorsal apparatus between the tendon of the extensor pollicis longus and the tendon of the adductor pollicis, and the capsule under the dorsal apparatus ruptured. The ulnar

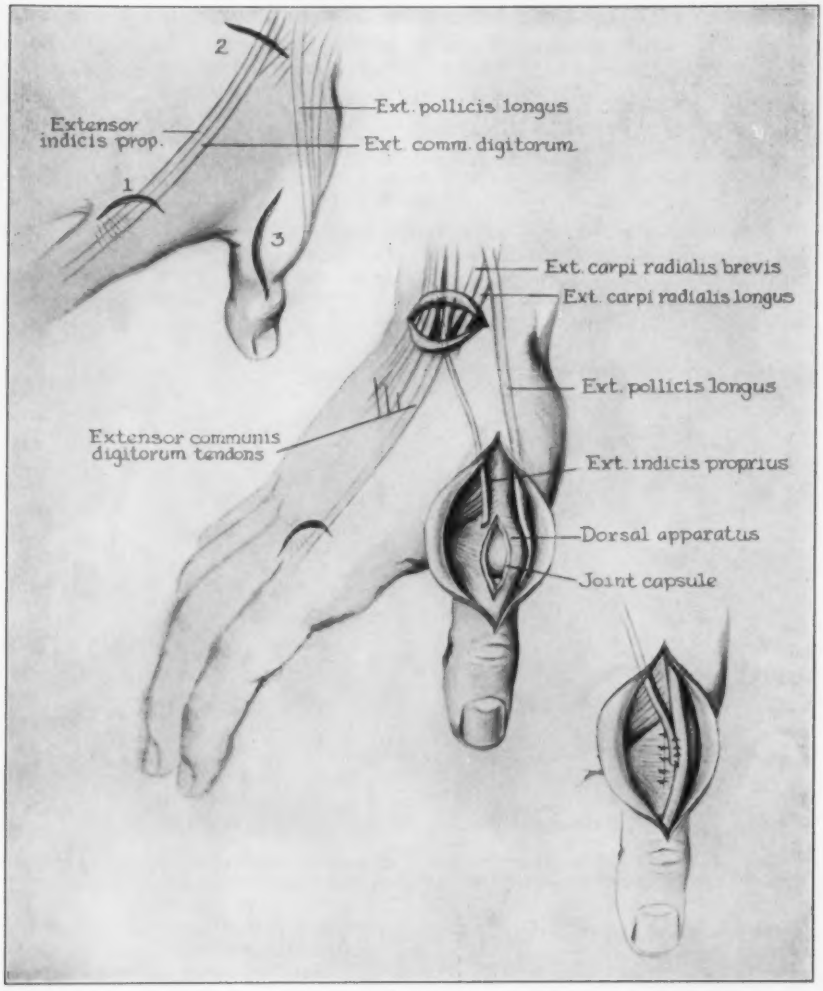

FIG. 4

Incisions for operative approach and details of operation.

collateral ligament remained intact but migrated toward the volar aspect of the joint, displacing the base of the proximal phalanx of the thumb volarward and producing radial rotation of the thumb.

Since the results of this experimental study were reported, additional experiments were carried out on six hands with the same results. It became clear within the limitations imposed by experiments on cadavera, that the deformity was caused by rupture or distention of the dorsal apparatus and the dorsal capsule of the joint, combined with gradual displacement of the tendon of the extensor pollicis longus to the radial side of the metacarpal head and of the tendon of the adductor pollicis with the sesamoid to the volar side of the joint. A gradual volar migration of the ulnar collateral ligament was responsible for the increase of the dislocation and the rotation of the thumb.

A method of treatment was then devised on the basis of this experimental

study. This method was designed to restore the dorsal apparatus of the metacarpophalangeal joint by bringing the displaced ulnar sesamoid of the thumb and the tendon of the adductor pollicis to its normal position and by restoring the tendon of the extensor pollicis longus, which was displaced radially around the protruding head of the first metacarpal, to its normal position over the center of the dorsal apparatus.

CASE REPORT

The previously mentioned patient (L.B., 60–3206), with a typical deformity after an automobile accident unsuccessfully treated by reconstruction of the ulnar side of the capsule, was operated on again (in April 1960) in accordance with the experimental findings.

Through an incision placed on the ulnar side of the thumb, the metacarpophalangeal joint was exposed. The dorsal apparatus of the thumb between the extensor pollicis longus and the adductor pollicis was found to be stretched out and scarred. The head of the metacarpal could be easily dislocated at the slightest pressure. The capsule of the metacarpophalangeal joint, which was distended and thickened, did not hold the head in place. The head of the metacarpal was found to be irregular in shape due to the presence of exostoses, thickened cartilage, and fibrous tissue; the

FIG. 5-A

FIG. 5-B

Fig. 5-A: Case L.B. Appearance of the metacarpophalangeal joint of the thumb after operation. The prominence of the transplanted extensor indicis proprius can be seen alongside the extensor pollicis longus.

Fig. 5-B: With thumb and index finger in pinch position, showing the extensor pollicis longus tendon placed in the normal axis of the thumb and its metacarpophalangeal joint.

changes resembled those on the head of the first metatarsal in cases of hallux valgus. The tendon of the adductor pollicis and the ulnar sesamoid were found displaced volarward toward the radial side of the thumb; the thumb was rotated so that its volar surface was turned toward the radial side. The tendons of the flexor pollicis longus and brevis were displaced in the same direction. All the scar tissue from the dorsal apparatus and the capsule was excised. The exostoses were removed with a chisel. The tendon of the adductor pollicis was pulled up toward the dorsal apparatus of the metacarpophalangeal joint and firmly sutured parallel to the tendon of the extensor pollicis longus, thus restoring it to its normal position and restoring the extensor pollicis longus tendon to its proper location over the center of the metacarpophalangeal joint. To ensure maintenance of the longitudinal position of the extensor pollicis longus over the center of the metacarpophalangeal joint of the thumb and thus to eliminate an important factor responsible for the subluxation of the head, the tendon of the extensor indicis proprius was transplanted.

The extensor indicis proprius tendon is invariably found at the ulnar side of the extensor indicis communis tendon at the metacarpophalangeal joint of the index finger. Through a separate small incision over the metacarpophalangeal joint of the index finger, the tendon of the extensor indicis proprius was divided at the metacarpophalangeal joint and withdrawn through another incision at the wrist. The tendon was then transferred subcutaneously to the metacarpophalangeal joint of the thumb, where it was sutured securely across the repaired area in the dorsal apparatus parallel to the tendon of the extensor pollicis longus (Fig. 4). The hand was immobilized in a plaster-of-Paris cast for six weeks.

The specimen submitted to the pathologist included three fragments of tough, white, fibrous tissue, 1.5 centimeters each in greatest dimension, and a fragment of cancellous bone, 1.5 by 0.5 by

0.3 centimeter, irregularly covered by cartilage, which was an exostosis removed from the metacarpal head of a patient with an old dislocation of the metacarpophalangeal joint of the thumb. All the tissue was embedded. The soft tissue from the metacarpophalangeal joint consisted of scarred muscle and articular capsule, much of the normal structure having been replaced by suture granulomata. The tissue removed from the distal phalanx was an irregularly shaped osteochondroma. The pathologist's diagnosis was osteochondroma of the thumb and suture granulomata.

On removal of plaster immobilization, it was found that the patient had normal function of the metacarpophalangeal joint with restoration of full power, absence of pain, and elimination of the protrusion of the head. The extensor pollicis longus remained in normal position over the dorsum of

FIG. 6

Case L.B. Postoperative roentgenograms of the metacarpophalangeal joint of the thumb.

the thumb. The transplanted tendon of the extensor indicis proprius was observed to be active over the metacarpophalangeal joint of the thumb, pulling on the extensor pollicis longus tendon in extension of the thumb. The patient was able to extend the thumb without extending the metacarpophalangeal joint of the index finger. Repeated examinations and final examination (in January 1961) showed complete functional and anatomical recovery (Figs. 5-A, 5-B, and 6).

CONCLUSIONS

Subluxation of the thumb is apparently caused by a disruption of the extensor apparatus and the dorsal capsule of the metacarpophalangeal joint, with secondary displacement of the tendon of the extensor pollicis longus toward the radial side of the thumb and of the tendon of the adductor pollicis toward the palmar side of the joint. A secondary radial rotation of the thumb follows. The head of the first metacarpal is displaced toward the ulnar side of the hand and changes develop that are similar to those observed on the head of the first metatarsal in hallux valgus. The changes of the head are probably due to repeated trauma and abnormal stress on the metacarpal head which is unprotected between the displaced extensor pollicis longus and the adductor pollicis.

Treatment requires replacement of the metacarpal head and restoration of the position of the extensor pollicis longus and the adductor pollicis tendon. Reinforcement of the dorsal apparatus and prevention of the displacement of the extensor

pollicis longus is obtained by transplantation of the tendon of the extensor indicis proprius over the metacarpophalangeal joint.

SUMMARY

The mechanism of subluxation of the metacarpophalangeal joint is explained on the basis of experimental production of the deformity. A method of treatment is suggested, consisting in restoration of the position of the extensor pollicis longus and adductor pollicis over the metacarpophalangeal joint with transplantation of the extensor indicis proprius to the dorsal apparatus and extensor pollicis longus tendon over the joint.

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Correction of Severe Deformity of the Cervical Spine in Ankylosing Spondylitis with the Halo Device

A Case Report

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The progressive flexion deformity of the head and trunk in patients with ankylosing spondylitis is associated with limitation of motion in the vertebral joints, yet it is quite difficult to determine from the clinical or roentgenographic examination when solid bony ankylosis has occurred. The tendency of the disease process to involve the extra-articular soft tissues before destruction of the underlying joints takes place has permitted various degrees of success in the prophylactic and corrective treatment of the deformity by conservative means. Non-operative treatment has included prolonged periods of bedrest with traction, exercises for muscle strengthening, casts, systemic administration of anti-inflammation drugs, or combinations of these methods. The value of a positive approach to conservative therapy is not questioned.

Operative treatment has not been used frequently; the procedures advocated have created a compensatory extension of the spine in the relatively safe lumbar region, thereby permitting the patient to stand more nearly erect, to see the horizon, and to walk with greater ease and safety, as has been emphasized by McMaster. There has been some reluctance to do this procedure on the lumbar spine because of the technical difficulties and hazards of the procedure and the problem of maintaining the desired position during the postoperative period. These same considerations have made operative correction of deformities of the cervical spine much less frequent, since the aforementioned deterrents are of even more concern in the cervical than in the lumbar region.

Osteotomy of the cervical spine has been carried out in this country and elsewhere with varying degrees of success [1,2,5], but this procedure will, in all likelihood, be reserved for those patients with far-advanced deformity that has not responded to other methods of therapy.

It is the purpose of this report to call attention to the fact that in certain cases of ankylosing spondylitis with primary deformity in the cervical region, a technique of correction and spine fusion without osteotomy may be applicable, as in the case to be reported.

H.R. (195867) was admitted to the Orthopaedic Service of the Vanderbilt University Hospital on November 8, 1959. He complained of inability to chew or swallow his food for several weeks. He had been aware of progressive flexion deformity of the spine for approximately four years. He had not been aware of any systemic illness, although he had had mild neck pain almost constantly. He had received no medical treatment prior to this admission and would have probably continued to live as he was, merely taking aspirin at home, had not chewing and swallowing become impossible.

Initial physical examination revealed a thin, well developed white man, who stood with moderate rounding of the thoracic spine. There was almost no chest expansion on inspiration. The head and neck were sharply flexed to the extent that the mandible rested against the sternum: the neck could not be actively extended. Passive extension of the neck permitted two fingers to be inserted

FIG. 1

FIG. 2

Fig. 1: Lateral roentgenogram of the cervical spine at the time of admission. Note the absence of ossification of the longitudinal ligaments and moderate subluxation of the fourth cervical on the fifth cervical vertebra.

Fig. 2: Lateral roentgenogram made after twenty pounds of skull traction for three days. Note that subluxation of the fourth on the fifth cervical vertebra has been reduced.

between the chin and chest. Both shoulders were capable of limited ranges of motion, and in both hips there was a flexion contracture of 45 degrees. Roentgenographic examination demonstrated the severe flexion of the cervical spine with changes compatible with the diagnosis of advanced ankylosing spondylitis (Fig. 1). A moderate anterior subluxation of the fourth on the fifth cervical vertebra was noted. In the thoracic and lumbar regions the articular processes showed moderate sclerotic changes. The sacro-iliac joints were obliterated.

It was evident that correction of the deformity of the cervical spine would be required to rehabilitate this patient. The treatment plan was based on the premises that the disease process was of relatively short duration, that bony ankylosis had not occurred, and that optimum correction should be obtained before stabilization by spine fusion. Precise control of the corrective forces throughout the period of treatment was vital to protect the spinal cord and spinal nerves.

Initially, in order to determine the magnitude of the correction forces required, Crutchfield tongs were placed in the skull, and gradually increasing traction and extension were applied. After three days of traction using twenty pounds, the subluxation of the fourth on the fifth cervical vertebra was reduced (Fig. 2). The traction weight was gradually increased over the next seven days to thirty-four pounds without apparent further improvement. It was believed that to increase the weight further might result in sudden disruption of the longitudinal ligaments with possible cord damage. Accordingly, the tongs were removed, and a metal halo device, such as that described by Perry and Nickel, was applied (Fig. 3). The corrective forces of extension and traction were then applied and were increased daily by adjustment of the three threaded uprights that suspend the halo proper and by backward movement of the entire suspension complex along the horizontal portions of the supporting angle rods attached to the plaster jacket.

It was anticipated that the strong but controlled leverage thus applied would force the partially ankylosed joints into extension or that the articular processes would gradually yield, together with the contracted anterior ligaments and annulus fibrosus, and thus restore the normal cervical lordosis.

During this period of correction, the patient was able to walk in the apparatus, and, except for transitory discomfort after the daily adjustment of the halo, he experienced no significant discomfort. It should be noted that the patient did not experience a snap or sudden change in position of the neck during the correction phase; the correction was obtained apparently as the result of gradual attenuation of contracted structures rather than of sudden rupture. It was necessary at one time during this phase to remove the apparatus and to rotate the supporting portion of the halo 180 degrees around a vertical axis because the corrective limits of the device had been reached. Originally, it had been necessary to apply the vertical supporting rods on the posterior aspect of the

FIG. 3

FIG. 4

Fig. 3: Photograph of the patient made approximately one week after surgery, illustrating the appearance of the halo apparatus in place. Originally, the uprights supporting the halo were applied behind the shoulders to compensate for the marked flexion of the cervical segment.

Fig. 4: Lateral roentgenogram made nine days after correction in the halo was instituted. Note the widening of the interspaces between the fourth and fifth cervical vertebrae and between the sixth and seventh cervical vertebrae. Most of the correction has occurred at these levels. Slight posterior subluxation has occurred at the interspace between the fourth and fifth cervical vertebrae.

jacket instead of in the usual anterior position because of the marked flexion deformity present. While the apparatus was being readjusted, a marked tendency for the deformity to recur was noted during the few minutes that corrective forces were not being exerted. The visible improvement in the deformity was confirmed by a series of roentgenograms, and, by the end of the ninth day of treatment in the halo device, satisfactory correction had been achieved (Fig. 4). Most of the correction occurred in the interspaces between the fourth and fifth cervical vertebrae and between the sixth and seventh cervical vertebrae. A slight posterior subluxation of the fourth on the fifth cervical vertebra was also present. The marked widening of the interspaces at the levels of correction suggested that the anterior longitudinal ligaments, the annulus fibrosus, and other soft tissues about these interspaces had been ruptured or markedly stretched. The normal cervical lordosis had been restored, and the relation of the skull to the upper cervical spine appeared to be satisfactory.

On November 27, 1959, an occipitothoracic fusion (occiput to the third thoracic vertebra) was carried out with the halo in place. This procedure was carried out under local anesthesia, and additional bone from the right posterior iliac crest was added to the fusion mass. A large dental burr facilitated denudation of the cortical bone of the skull and laminae without the application of excessive forces to the cervical areas.

The patient's postoperative course was benign. He required no narcotics during the first twenty-four hours after surgery and was able to walk on the second postoperative day. He was discharged from the hospital on the eighth postoperative day, wearing the halo.

The patient was followed on an out-patient basis at intervals of two to four weeks. Except for minor problems associated with pressure areas from the plaster jacket, no complications were encountered. There was never any evidence of pin-tract infection, although the halo was left in

FIG. 5

FIG. 6

Fig. 5: Lateral roentgenogram made six and a half months after operation. The halo device had been removed two and a half months earlier. Correction has been maintained and there is evidence of early consolidation of the graft.

Fig. 6: Photograph of the patient's profile, made approximately one year after operation, illustrating maintenance of a relatively normal cervical curve.

place for a total of four months after surgery. At the end of four months, the halo was removed, and a posterior plaster shell was constructed for night use. Roentgenograms two and a half months after removal of the halo revealed maintenance of correction and early consolidation of the fusion mass (Fig. 5).

At the time of writing, thirteen months after fusion, there was no evidence of recurrence of the deformity (Fig. 6). The patient returned to his occupation as a farmer and stated that he is able to drive his automobile and tractor and do many of the lighter chores on his farm. In an attempt to prevent further deformity in other areas of his spine, the patient has been instructed in appropriate exercises, such as chest-expansion and hyperextension exercises; in addition, he has learned to sleep in the supine position on a firm bed. It is anticipated that arthroplasty of one or both hips may be necessary in the future.

DISCUSSION

Ankylosing spondylitis infrequently produces primary cervical deformity. For individuals so affected, cervical osteotomy by the anterior, posterior, or combined approaches has been the only procedure available to correct the severe deformities. Osteotomy of the spine at this level, when controlled by the usual means of immobilization, is hazardous and has resulted in death [1]. While the procedure outlined is not without hazard, it would appear to be safer than osteotomy, for the following reasons: (1) Posterior subluxation with resultant cord damage constitutes one of the real dangers of cervical osteotomy. Although rupture of the posterior longitudinal ligament with some dislocation posteriorly may presumably occur in the halo method also, the intact posterior elements tend to prevent any but the most minor slippage; (2) The strong traction forces being exerted on the surrounding soft tissues tend to align the cervical segments unless extreme extension forces are also applied; and (3) Since correction is quite gradual and the patient is not anesthetized during correction, any symptoms resulting from abnormal pressures on nerve roots or the cord should be readily apparent and

FIG. 7

FIG. 8

Fig. 7: Side view of the modified halo now employed by the author. Serrated discs located at the base of each upright allow flexion-extension movements, while a second ring supporting the halo proper allows rotation of the head and neck without removal of the skull pins.

Fig. 8: Close-up view of the upright base and serrated disc.

easily relieved by readjustment of the device, or, if necessary, by open decompression. I have employed the halo as a reduction-immobilization device in several cases of fracture-dislocation of the cervical spine and have been gratified at the ease with which radicular pressure symptoms may be alleviated by adjustment of the apparatus. A summary of these additional cases is now being prepared for publication.

Since the halo was designed to maintain immobilization in patients with flail head and neck muscles, there is considerable limitation in the range of correction that can be obtained in the conventional model, as was evidenced by this case. For this reason, a modified suspension system has been designed to overcome this difficulty (Figs. 7 and 8).

SUMMARY

1. A method of traction correction of severe deformity of the cervical spine resulting from ankylosing spondylitis has been presented.

2. It is suggested that the halo described by Perry and Nickel may have a wide application in problems requiring carefully controlled adjustment of position and immobilization of the cervical spine and skull.

3. A case has been reported in which the halo was used for correction and immobilization in conjunction with occipitothoracic spine fusion under local anesthesia.

4. The halo-fusion technique is believed to be safer than the less precise immobilization techniques; the minimum discomfort experienced by the patient

in this device is remarkable and is apparently the result of the rigid immobilization of the skull and cervical spine.

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Bilateral Recurrent Dislocation of the Shoulder (Atraumatic) in a Thirteen-Year-Old Girl

Report of an Unusual Case

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The following case study is deemed worth recording because of several unusual features, including the age at onset, the absence of trauma or other demonstrable etiological factors, the frequency of dislocation, and the suspected psychological problems of the patient that were thought to cause voluntary dislocation in many instances.

M.A., a white girl, thirteen years old, of Spanish-American descent, was first seen in the Out-Patient Department of Variety Children's Hospital with the chief complaint of recurring dislocations of the right shoulder, occurring with increasing frequency, during the preceding five months. The shoulder had dislocated ten times during the day of initial examination. When the child was first examined it was evident that she could easily dislocate the shoulder by voluntary contraction of the depressors and external rotators of the shoulder, but it was also apparent that the dislocation occurred without any demonstrable voluntary effort on the patient's part. Reduction could be accomplished without much difficulty by the usual methods but it could not be maintained consistently when the patient was awake.

Although the left shoulder had been dislocated three times in the past, it did not constitute a problem at the moment.

The history obtained from the patient and the parents indicated that the first dislocation of the right shoulder occurred at the age of seven years. Despite careful questioning, trauma to the shoulder was denied. However, the parents did not appear to be very reliable observers, and the relationship between the child and her parents was not very satisfactory.

The patient's first dislocation had been reduced by a local physician, and the shoulder was immobilized in a sling for approximately one week. Three months later the left shoulder dislocated spontaneously; it was reduced and treated in the same manner as the right shoulder. Thereafter, the child engaged in normal activities and had no further difficulty until approximately six months before examination. At that time there began a series of dislocations of the right shoulder, and three dislocations of the left shoulder occurred. None was associated with any trauma. Some required reduction by a physician, others were reduced by the patient or her family. For the most part, postreduction immobilization was not used.

The child's birth and developmental history were not remarkable, and the family history was not contributory.

Physical examination on admission showed a well developed, well nourished, cooperative, white girl, in no acute distress, despite the obvious anterior subcoracoid dislocation of the right shoulder. There were no abnormal findings on general physical examination. A detailed evaluation of muscle strength and neurological examination done subsequently revealed no abnormalities.

The examiner could easily dislocate both shoulders with a gentle forward thrust on the proximal end of the humerus, even when the arm was held in a position of adduction and internal rotation. Any voluntary attempt on the part of the patient to externally rotate or abduct either arm resulted in dislocation of the shoulder. The wrist and fingers on both sides could be hyperextended to an abnormal degree, but no other evidence of a connective-tissue diathesis was noted. There were no dental abnormalities or hyperelasticity of the skin.

Laboratory data, including a hemogram and urinalysis, were normal. Roentgenograms of both shoulders in the dislocated position revealed both humeral heads to be displaced anteriorly in the subcoracoid position. Special views failed to reveal any defect in the humeral head.

Both shoulders were operated on (the right on October 31, 1959, and the left on December 2, 1959), with a six-week interval between procedures. Both shoulders had extremely lax and redundant capsules without a tear. On the right, the labrum was separated from the glenoid fossa

at its inferior pole; on the left, there was no detachment of the labrum. The glenoid fossa in both shoulders appeared to be normally constituted, and both humeral heads were uniformly globular. An elliptical segment of the redundant anterior capsule was excised, just lateral to the labrum, and the lateral portion of the divided capsule was anchored to the neck of the scapula, after the manner of Bankart. In addition, the insertion of the subscapularis muscle was transposed to the lateral aspect of the bicipital groove.

Both shoulders were immobilized in a plaster-of-Paris, Velpeau-type dressing for a period of four weeks, then graduated exercises to mobilize the shoulder and restore muscle strength were started.

The patient was hospitalized during much of this time because of difficulties with transportation to and from her home. Before operation both shoulders were dislocated an amazing number of times, both voluntarily and involuntarily. During one twenty-four-hour period subsequent to the repair of the right shoulder, seventy-six voluntary dislocations of the left shoulder were recorded.

At the time of writing, one and a half years since operation on the right and one year, four months since operation on the left shoulder, both shoulders have regained a normal range of motion, except that external rotation is limited to 45 degrees on both sides. No further dislocations have occurred.

COMMENT

We have not found any previous reports in the literature of a similar case occurring in a person of this age, either with or without trauma, excluding, of course, neuromuscular disorders or gross structural abnormalities. A connective-tissue diathesis must be considered, but the only other manifestation suggesting this was the hyperextension of the wrists and fingers. Even if there were such a diathesis, the dislocations of the shoulder in this girl would be most unusual. Some traumatic incident may also have occurred, even though this was denied by the parents and child. Although formal psychological evaluation was not done, it was our strong impression that this girl was emotionally disturbed, and, undoubtedly, she voluntarily dislocated her shoulders on many occasions to gain the attention of her family and other persons. Repeated voluntary dislocations with inadequate initial immobilization presumably contributed to the increasing ease with which her shoulders could be dislocated as time progressed.

Arthrodesis of a Prosthetic Hip Joint

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The chances of obtaining a successful arthrodesis of the hip joint are greatly reduced when the head and neck of the femur are missing. The decision to perform replacement arthroplasty using an intramedullary type of prosthesis is sometimes referred to as "burning your bridges behind you" insofar as a fusion is concerned, since the femoral head and neck are removed. Although fusion can still be achieved between the greater trochanter and acetabulum after removal of such a prosthesis, this is considered difficult and usually results in shortening of the extremity.

FIG. 1

Roentgenogram made in July 1956, showing aseptic necrosis and collapse of the right femoral head and early changes in the subchondral region of the left femoral head.

In the following report, successful arthrodesis of one hip joint after unsuccessful arthroplasty is described in a patient with bilateral prosthetic arthroplasty. Bony ankylosis between the femur and pelvis was achieved with the intramedullary metal prosthesis *in situ*, and thus the length of the extremity was preserved.

At the time that this procedure was carried out in April 1959, no report of a similar procedure was found in the English literature, but, since then, a comparable procedure was described by Coleman and Hunter.

CASE REPORT

In July 1956, a Negro man, thirty-three years old, was admitted to the hospital because of pain in the right hip that had persisted for about a year. There was no history of trauma. The patient had had gonorrhea three times in the past, as well as syphilis while he was in the army, for which he received adequate treatment.

Physical examination revealed painful, restricted motion of the right hip. The left hip joint appeared normal clinically. The laboratory findings were within normal limits. Roentgenograms of the right hip revealed aseptic necrosis of the femoral head (Fig. 1). At the same time, minimum osteochondritic changes were noted on the roentgenograms of the left femoral head (Fig. 1). Arthroplasty of the right hip was performed in September 1956, and a stainless-steel Judet pros-

FIG. 2

Roentgenogram made in December 1956, showing increasing sclerosis and beginning collapse of the left femoral head. The Judet prosthesis appears to be stable.

FIG. 3

Roentgenogram made in December 1958, showing the Judet prosthesis of the oblique type in the left hip and the Austin Moore prosthesis in the right hip replacing the Judet prosthesis of the conventional type which had become unstable.

thesis of the conventional type was inserted through a Smith-Petersen approach (Fig. 2). The patient began walking with crutches about five weeks after surgery. Seven weeks after operation the patient was able to walk without pain in the right hip, with the aid of a cane. However, there began to be pain in the opposite hip; additional roentgenograms revealed that aseptic necrosis was also developing in the left femoral head while the patient was in the hospital. The patient remained under observation until May 1957, at which time arthroplasty was carried out on the left hip. This time a stainless-steel Judet prosthesis of the oblique type was inserted through a Smith-Petersen approach. Initially, an excellent functional result was obtained in both hips. For nine months after the second operation, the patient was able to walk painlessly without support. He had an excellent range of hip motion and good muscle strength. The Trendelenburg test was negative bilaterally. The patient went to work as a taxi driver. In February 1958 he began to have pain in the right

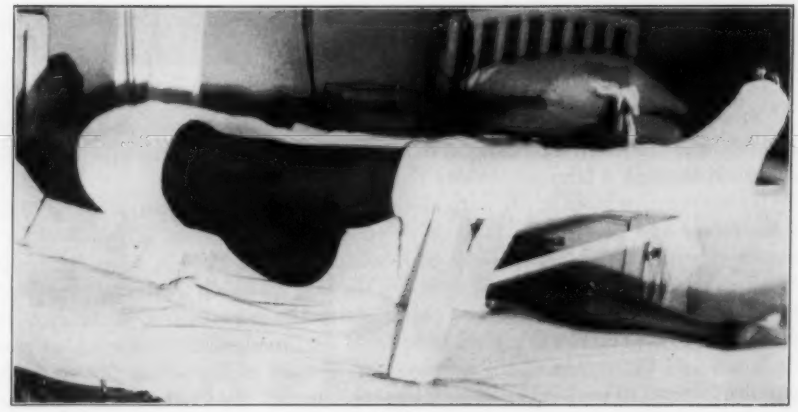

FIG. 4

The one-and-one-half spica cast, with a large window, in which the patient was placed before operation. Wooden and metal struts (not shown in this view) were placed on the anterior aspect of the cast to provide strength because, when the window was opened, there remained only a narrow bridge of plaster anteriorly between the leg and the body portions of the cast. The window cover was replaced after surgery and periodically removed when roentgenograms were made.

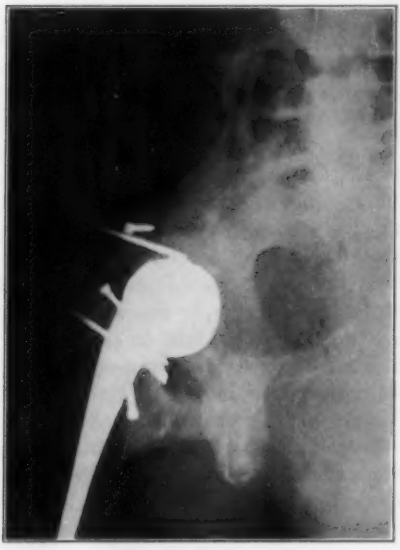

FIG. 5-A

FIG. 5-B

Fig. 5-A: Lateral roentgenogram of the right hip joint made two years after arthrodesis, in April 1961, showing the anterior bone graft.

Fig. 5-B: Anteroposterior roentgenogram of the right hip joint made two years after arthrodesis in April 1961.

hip, and roentgenograms revealed instability of the right prosthesis within the femur. The left hip remained asymptomatic.

In April 1958, the Judet prosthesis on the right was replaced by an Austin Moore prosthesis, through a Watson-Jones approach (Fig. 3). The patient carried out the routine postoperative exercises satisfactorily, but, in May 1958, pain developed in the right hip on motion and weight-bearing, and the pain and disability became progressively worse. He remained at home, using crutches, until February 1959, when he was again hospitalized; at this time he had more pain in the right hip, especially on weight-bearing. The left hip remained asymptomatic, and the prosthesis

appeared to be stable as seen on the roentgenograms. Arthrodesis around the prosthesis in the right hip was performed early in April 1959.

TECHNIQUE OF OPERATION

The patient was placed in a specially designed plaster spica cast, with the right femur in the desired position in relationship to the pelvis. The operation was performed through a large window in the cast (Fig. 4).

Three massive bone grafts were placed around the metal prosthesis and fixed to the femur and pelvis. The main graft consisted of a portion of full-thickness iliac crest with the gluteal muscles still attached. This pedicle bone graft was placed on the superior and lateral aspect of the hip, spanning the metal prosthesis from the greater trochanter to the pelvis above the acetabulum. Another bone graft from the iliac crest was placed anterior to the prosthesis; it extended between the femur and the region of the antero-inferior spine of the pelvis. These grafts were firmly fixed in position with stainless-steel screws. Finally, a graft of cortical bone from the bone bank was placed between the femur and ischial tuberosity, according to the technique of Trumble. This graft bridged the prosthesis postero-inferiorly. A subtrochanteric osteotomy was also carried out to eliminate the leverage of the extremity on the grafts while they were being incorporated.

A Gigli saw and a sharp osteotome were used to carry out the osteotomy around the stem of the prosthesis. When the osteotomy was completed, slight motion could be demonstrated at the osteotomy site, despite the presence of the stem of the prosthesis within the medullary canal. A skin incision of the Smith-Petersen type was used, but it was necessary to develop a large skin flap in order to obtain access to the anterior, lateral, and posterolateral aspects of the hip for the placement of the three grafts.

The patient remained in a one-and-a-half plaster spica cast for three and a half months; this was then reduced to a single spica cast for eighteen days and then to a short single spica cast extending to just above the knee for two months to allow knee motion. This plaster was removed six months after surgery, when roentgenograms showed bone fusion around the prosthesis. When the patient was discharged from the hospital eight months after surgery, he was able to walk well without support; he had no pain and could bear full weight on either lower extremity. When last seen, one year from discharge, he was symptom-free and when last seen on April 3, 1961, two years after operation, he was walking without support; his gait was easy and painless. He stated then that after walking long distances he experienced some "soreness" about his left hip, but his right hip was symptom-free. The Trendelenburg test was negative on both sides. Flexion in the right knee was to slightly more than 90 degrees. Roentgenograms of the right hip showed that the laterosuperior and postero-inferior grafts were solid and incorporated (Fig. 5-A). Although a defect was visible in the anterior graft, there remained a bridge of bone anterior to the prosthesis (Fig. 5-B).

COMMENT

This is a formidable surgical procedure which should not be undertaken lightly. In the case reported by Coleman and Hunter, two operations were required to obtain solid fusion. In the case that I have just presented, three massive bone grafts, two of them fixed in position with screws, were placed around the metal prosthesis. Every known precaution to ensure successful incorporation of the grafts was taken, including adequate fixation of the grafts (one of them being a pedicle bone graft of the Davis type), a subtrochanteric osteotomy, and immobilization in a spica cast. The objective of the procedure was to produce, in one

operation, bone bridges of sufficient strength to withstand the forces known to exist around the hip joint. It is worthy of note that, after discharge from the hospital, the patient tripped and fell but did not damage his arthrodesis.

The advantages of this operation are: (1) preservation of length of the extremity, (2) a better gait, and (3), consequently, less strain on the lower part of the back.

The disadvantages are: (1) the unknown fate of the retained metal prosthesis, (2) increased danger of infection owing to the presence of the large foreign body, and (3) the technical complexity of the procedure.

I believe that the advantages of this procedure in selected cases outweigh the disadvantages.

SUMMARY

Arthrodesis of a painful hip with the prosthesis still *in situ* was achieved after bilateral hip arthroplasty. The arthrodesis was performed at one time, placing three massive bone grafts anterior, superior, and postero-inferior to the prosthesis. Thus, the length of the extremity was preserved, and the optimum position of the hip could be achieved. This procedure is formidable, but is believed to have more advantages than disadvantages in selected cases.

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Cystic Tuberculosis of the Proximal Tibial Metaphysis with Associated Involvement of the Epiphysis and Epiphyseal Plate

A Report of Two Cases

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Tuberculosis of the long bones in children is very uncommon today. Lesions of the spine and hip continue to be the most frequent osteo-articular manifestations of tuberculosis in children seen at the University of Michigan Medical Center. Two lesions involving the tibial metaphysis and epiphysis with penetration of the cartilaginous epiphyseal plate were recently encountered in two young boys. Curettage and drug therapy led to arrest of the disease process, and no interference with growth was noted.

In 1914, Fraser described four types of osseous tuberculosis: the encysted lesion, the infiltrative lesion, the atrophic lesion, and the hypertrophic lesion. He stated that the encysted tubercle was the most common and most chronic form of bone tuberculosis. In his discussion of the treatment of encysted bone tuberculosis Fraser advised scraping of the cavity followed by iodoform packing and wound closure. The limb was then placed in plaster for up to six months. Fraser credited Sir Harold Stiles with the advocacy of subperiosteal excision of the encysted tuberculous lesion. Favorable results followed curettage or excision.

In 1920, Jüngling described a condition of multiple cystic lesions in the metacarpals, metatarsals, and phalanges of young adults. A few long bones were affected. Jüngling thought the lesions were tuberculoid. He regarded them as a peculiar form of tuberculosis closely associated with Boeck's sarcoid or lupus pernio. Jüngling found no sequestra, sinus formation, or joint involvement. The tuberculin reactions were negative and cultures of sputum and bone lesions did not grow the tubercle bacillus.

In 1934, Van Gorder reported six cases of tuberculosis of the long bones. He pointed out that the response of the bone varied according to the stage of the disease, the region of the shaft involved, and the resistance and ability of the bone elements to wall off the invading tuberculous focus. When the diaphyseal portion of the bone was involved, periosteal and lamellar reaction about the tuberculous focus was very marked, and local expansion of the shaft was one of the outstanding roentgenographic features. However, when the metaphyseal portion of a long bone was involved, little or no reaction was manifested by either the periosteum or the adjacent bone lamellae to the bone abscess. Van Gorder carried out subperiosteal excision of the lesion in all six patients with subsequent healing in five. Primary closure of the wound was carried out unless a sinus was present.

In 1940, Carrell and Childress reviewed the English literature and found thirty-two reported cases of tuberculosis of the long bones. In addition, these authors sent a questionnaire to 250 orthopaedic surgeons in the United States and Canada. This survey produced seventy-four previously unreported cases. Coupled with their own experience, Carrell and Childress were able to report on 123 lesions in ninety-five patients.

The tibia and femur were most often involved and the lesions were of two

general types. The encysted metaphyseal lesion caused slight bone reaction. On the other hand, diaphyseal lesions tended to be chronic infiltrative in type and caused considerable periosteal reaction with new-bone formation and sclerosis of the shaft. Associated pulmonary or spinal disease was common and contributed to the high mortality (19 per cent) reported in this series. No specific comments regarding involvement of the epiphyseal plate were given.

Since these patients were treated prior to specific antibiotic therapy, the results obtained are of great interest. Ten cases were considered amenable to curettement and closure; healing was reported in all but one. Incision and drainage led to healing in twenty-five (66 per cent) of thirty-eight patients. Amputation or excision of the disease focus was done in the more severe cases of the disease. The lesions in five patients were reported to have healed without operation.

Most authors state that the usual localization of tuberculous infection in long bones is in the metaphysis along the epiphyseal plate. Primary lesions in the shaft are far less common than metaphyseal lesions. Chandler described the pathogenesis of the metaphyseal lesion, pointing out that the adjacent bone may be stimulated to more rapid growth or the destructive action of the tubercle bacillus may predominate with the formation of an enlarging abscess. The abscess may remain local, forming a cavity along the epiphyseal plate, or the abscess may erode through the epiphyseal plate and perforate the joint cavity by direct extension. Invasion of the joint may also occur by extension of the process along the epiphyseal plate to the point of origin of the joint capsule.

During a review of the case records of The Peabody Home, Sanchis Olmos found forty-five patients (11 per cent) with tuberculosis of the knee joint or the bones that constitute the knee. He stated that growth of the limb can be altered as a consequence of juxta-articular foci of tuberculosis. Although no statistics regarding the effect on growth were given, several illustrative cases showing alteration of growth were presented. Case 480, illustrated on page 213 of the Sanchis Olmos book, is very similar to the cases reported in this paper. In this example of exudative osteitis of the proximal tibial metaphysis and epiphysis, growth of the proximal tibial epiphysis was arrested.

Haas showed that arthrodesis of the knee can be carried out in very young children with tuberculosis of that joint without impairment of growth of the leg. He emphasized, however, that care must be taken not to injure the epiphyseal cartilage plate.

Girdlestone and Somerville stated that infection of the knee joint frequently occurs by an indirect route after infiltration and erosion of bone. In this type of involvement, the prognosis is relatively unfavorable. Whenever a joint exhibits irritability in the presence of a closely associated extra-articular focus of bone tuberculosis, Girdlestone and Somerville regard the joint as infected also. They suggested that if the bone focus of disease is not associated with joint involvement, eradication of the focus by an extra-articular route is indicated. However, when a bone focus has opened through the articular cartilage into the knee, the best result obtainable is ankylosis.

With the introduction of anti-tuberculosis drugs, surgeons have been cautiously optimistic that skeletal foci of tuberculosis might be eliminated without the necessity of joint fusion. Smith emphasized the fact that tuberculous lesions in bone, apart from a joint, could be extirpated and cured without ablation of the joint. Prior to the use of drug therapy, Smith had not seen any cases in which intra-articular lesions were cured without arthrodesis. He suggested attempts should be made to treat the bone lesion without arthrodesing the joint in patients in whom the articular surfaces are not destroyed.

FIG. 1-A

FIG. 1-B

Fig. 1-A: Case 1. No bone destruction was visible on this anteroposterior roentgenogram of both knees made on June 20, 1957.

Fig. 1-B: The roentgenogram of the left knee, made on August 6, 1957, shows a distinct area of bone lysis in the lateral aspect of the tibial epiphysis and metaphysis.

FIG. 1-C

FIG. 1-D

Fig. 1-C: A roentgenogram of the left knee, made on October 10, 1957, shows that the lytic lesion in the metaphysis and epiphysis is enlarging.

Fig. 1-D: Roentgenogram of the left knee, made on December 18, 1957, after curettement of the lesion.

Smith and Bailey reported that in five cases of synovial tuberculosis of the knee in which there was no roentgenographic evidence of bone involvement there was apparent clinical cure after treatment with streptomycin combined with plaster immobilization. Dougherty and Sherman reported four cases of tuberculous arthritis in children. In three of the children, a concomitant focus of tuberculous osteomyelitis was curetted and the disease arrested. Streptomycin therapy was utilized in all four cases.

CASE REPORTS

CASE 1. J. G., a six-year-old white boy, was investigated for pulmonary tuberculosis in June 1957, because of the recent discovery of active pulmonary tuberculosis in his mother. A roentgenogram of his chest suggested active parenchymal disease and the old tuberculin skin reaction was positive. *Mycobacterium tuberculosis* was cultured from gastric washings. The organism was relatively resistant to streptomycin. The patient was placed at bedrest and was started on anti-tuberculosis drugs (isonicotinic acid hydrazide, 150 milligrams per day, and para-aminosalicylic acid, four grams per day). One month later, the patient began to complain of discomfort in his left knee in the

FIG. 1-E

FIG. 1-F

Fig. 1-E: Roentgenogram of the left knee, made on August 7, 1958, shows orderly epiphyseal growth. The cystic lesion in the tibial metaphysis has moved away from the epiphyseal line.

Fig. 1-F: Anteroposterior and lateral roentgenograms of the left knee, made on September 4, 1959, show that the cystic lesion has moved further from the epiphyseal line and is less distinct.

FIG. 1-G

Roentgenograms of the left knee, made on March 6, 1961, show further healing and no deformity.

popliteal area. Physical examination and roentgenograms of the knee were normal (Fig. 1-A). Roentgenograms made six weeks later (August 1957) showed a destructive lesion involving the metaphysis and epiphysis of the proximal part of the tibia (Fig. 1-B). A toe-to-groin plaster cast was applied. The lesion progressed in size despite immobilization and drug therapy (Fig. 1-C). In October 1957, it seemed that joint involvement might occur, so the lesion was excised. The cavity was entered from the lateral aspect of the tibial metaphysis. The cavity was lined by a membrane of gray-brown, partially necrotic, granulation tissue. A small amount of caseous purulent material emerged from the cavity and cultures were made of this material. These cultures were positive for *Mycobacterium tuberculosis*. The perforation through the epiphyseal plate joining the epiphyseal and

FIG. 2-A FIG. 2-B

Figs. 2-A and 2-B: Case. 2. Anteroposterior and lateral roentgenograms of the left knee, made on September 10, 1958, show a lytic lesion extending from the proximal tibial epiphysis into the metaphysis.

FIG. 2-C

Anteroposterior and lateral roentgenograms of the left knee, made on October 4, 1959, show that the cystic lesion is becoming less distinct. Orderly metaphyseal growth is illustrated by the movement of the line of increased bone density away from the epiphyseal line. This line is thought to represent a period of retarded growth during the acute phase of the infection.

metaphyseal lesions was clearly evident. Several small bone sequestra were removed from the epiphyseal cavity through the defect in the plate, as well as from the metaphyseal lesion. The granulation tissue lining the cavities was carefully curetted to avoid further damage to the epiphyseal plate. When the lining membrane of granulation tissue had been removed, the margins of the

FIG. 2-D FIG. 2-E

Anteroposterior and lateral roentgenograms of the left knee, made on July 6, 1960, show that the lesion is less distinct. No alteration of growth is evident.

cavity were seen to be made up of trabeculae of smooth dense bone, similar to that seen in the wall of the simple bone cyst.

The defect in the epiphyseal plate was one centimeter in diameter and was located in the

FIG. 2-F

Roentgenograms of the left knee, made on March 6, 1961, show that orderly growth has continued. The lesion is less apparent than before.

lateral portion of the plate (Fig. 1-D). One gram of streptomycin was instilled in the cavity, the wound was closed primarily, and a toe-to-groin cast was applied. Immobilization was continued for three months followed by partial immobilization in a bivalved cast for an additional three months. Four grams of para-aminosalicylic acid and 150 milligrams of isonicotinic acid hydrazide were given daily for eighteen months after operation.

Follow-up clinical and roentgengraphic examinations showed the lesion to be arrested. Despite the perforation of the epiphyseal plate, the proximal tibial epiphysis has continued to produce normal growth of the tibial shaft (Figs. 1-E, 1-F, and 1-G). The latest examination, three years and five months after operation, revealed a normal knee with a full range of motion and an increase in leg length of one-fourth of an inch over the uninvolved leg (Fig. 1-G).

CASE 2. R. H., a white boy, two years and four months old, was admitted to the University Hospital on September 10, 1958, with a six-week history of discomfort in the left calf. A slowly enlarging mass in the calf had been noted by the parents. There was no history of antecedent trauma or infection. Physical examination showed a slightly fluctuant and mobile mass, six by seven centimeters, in the area of the left gastrocnemius muscle. The mass extended upward to the popliteal space. Roentgenograms of the left tibia showed a lytic lesion involving the proximal epiphysis and metaphysis (Figs. 2-A and 2-B). On September 25, 1958, incision and drainage of the calf abscess was carried out on the general surgery service. Two ounces of thick yellow pus was removed along with several masses of granulation tissue. Tissue examination revealed caseating tuberculous granulation tissue and acid-fast organisms. The culture of the pus was positive for *Mycobacterium tuberculosis*, which was resistant to streptomycin in concentrations of twenty-five micrograms per cubic centimeter.

The patient was transferred to the orthopaedic surgery service and a toe-to-groin cast was applied. The patient was started on 0.5 gram of streptomycin, 150 milligrams of isonicotinic acid hydrazide, and four grams of para-aminosalicylic acid a day. Two months later, the site of drainage of the calf abscess was healed. The osseous lesion, however, had progressed in size and definite sequestra were noted. Curettement was carried out, the lesion being exposed through a window created in the lateral cortex of the tibia. The metaphyseal cavity was entered and approximately two cubic centimeters of thick yellow pus was removed and cultured. This culture was positive for *Mycobacterium tuberculosis*. The metaphyseal cavity was lined with a thick layer of rather gelatinous tissue with some areas of caseation. Small spicules of bone were removed with this membrane along with a larger sequestrum. The bone margins of the cavity were made up of smooth, dense trabecular bone. Directly posterior, the tibial cortex had been destroyed, leaving a defect half a centimeter in diameter beneath the periosteum. This defect represented a track whereby the osseous abscess had apparently eroded through the cortex to produce the soft-tissue abscess in the calf.

Proximally, there was a circular defect about one centimeter in diameter completely traversing the epiphyseal plate and communicating with a second cavity in the epiphysis. This cavity was curetted with great caution through the defect in the epiphyseal plate. Granulation tissue and a large, rounded, pea-sized sequestrum were removed from the epiphyseal cavity. One gram of streptomycin was instilled in the lesion and the wound was closed primarily.

Anti-tuberculosis drugs were continued for two years after operation. The child was in a plaster cast for seven months after operation, although during the last three months of immobilization, the cast was bivalved so that passive range-of-motion exercises could be carried out.

Follow-up examinations through March 1961, more than two years after operation, have shown a full range of knee motion, equal leg length, and progressive healing of the metaphyseal portion of the lesion (Figs. 2-C, 2-D, and 2-E). The cystic defect in the proximal tibial epiphysis remains prominent. There has been no evidence of a growth disturbance or of recurrence of the infection (Fig. 2-F). During the past eight months, both legs have increased one inch in length.

DISCUSSION

Both of these patients manifested a progressive, destructive focus of tuberculous osteomyelitis with involvement of the proximal tibial metaphysis, epiphysis, and epiphyseal plate. Neither patient showed gross clinical evidence of joint involvement. Although some synovial thickening seemed to be present on physical examination, no effusion, swelling, or increased heat was noted in the knee. In Case 1, J. G., the abscess in the tibia made its appearance and progressed despite intensive drug therapy and immobilization. In Case 2, R. H., the abscess eroded through the posterior cortex of the tibia and expanded into the posterior muscle

mass of the calf and into the popliteal space. A large sequestrum was removed from the epiphysis of Case 2.

After curettage of the abscess and prolonged chemotherapy there was roentgenographic evidence of arrest of the osseous lesion and apparent resumption of normal growth from the proximal tibial epiphyseal plate. Growth is apparently continuing in an orderly manner despite the known defect in the epiphyseal plate.

SUMMARY AND CONCLUSIONS

Two cases of cystic tuberculosis in children with involvement of the proximal tibial metaphysis, epiphyseal plate, and epiphysis are presented.

In each case, curettage of the abscess with removal of sequestra combined with drug therapy and immobilization have led to arrest of the disease.

In each case, the organism showed resistance to streptomycin when first encountered.

Symmetrical growth of the tibia has continued despite known penetration of the epiphyseal plate. The value of surgical extirpation of the osseous lesion combined with drug therapy in these examples of cystic tuberculosis is apparent.

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Osteoid Osteoma of the Lumbar Spine*

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Two cases of osteoid osteoma of the vertebra were studied. The symptoms and signs in our cases have been previously described [1,2,3,5,6,7,8]. A report is justified because the clinical diagnosis of this rare condition remains difficult.

CASE 1. N. W., a twelve-year-old girl, was first seen in March 1943 with complaints of low-back pain and curvature of the spine. She had fallen from a horse in August 1942, and one month later experienced aching back pain which increased with fatigue and was often severe at night. It was not recorded whether or not her pain responded to salicylates. In January 1943 scoliosis developed and a torso cast was applied by her family physician. It failed to control the pain or the increasing deformity.

FIG. 1

The arrow indicates an area of increased density and distortion of the right pedicle and lamina of the second lumbar vertebra.

She was seen in March 1943 with a right thoracic, left lumbar scoliosis and a list to the right. There was tenderness of the right upper lumbar area with paravertebral muscle spasm. Elevation of the right iliac crest suggested spasm of the right quadratus lumborum. Lumbar motion was obliterated except for normal rotation and bending to the right which was 80 per cent of normal. Attempted backward bending aggravated her pain.

The anteroposterior roentgenogram (Fig. 1) showed a defect in the superior margin of the

*This material has been reviewed by the Office of the Surgeon General, Department of the Army, and there is no objection to its presentation and publication. This review does not imply any endorsement of the opinions advanced.

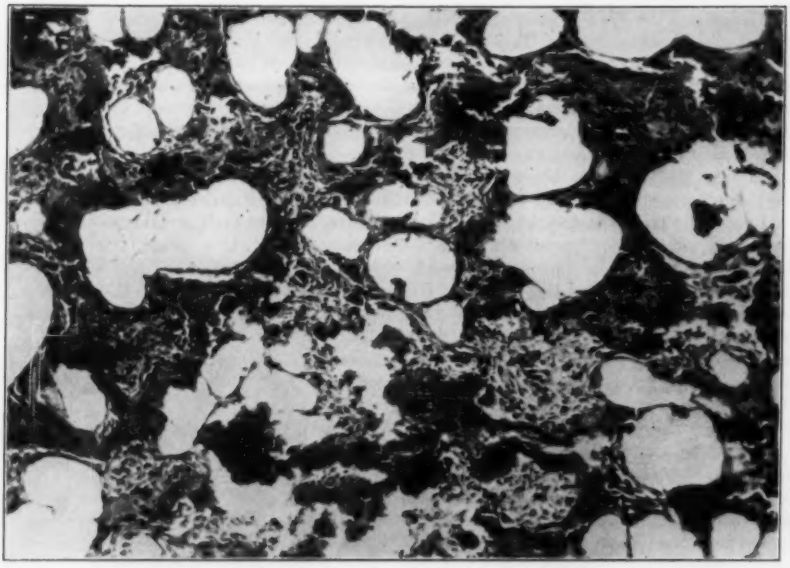

FIG. 2

There are thinned fibrous trabeculae with areas of osteoid formation (×80).

lamina and enlargement and distortion of the pedicle, lamina, and transverse process of the second lumbar vertebra on the right. Additional views were less informative.

Surgical exploration in March 1943 disclosed a pink granulomatous lesion covering the ligamentum flavum between the laminae of the first and second lumbar vertebrae on the right. The abnormal tissue was all removed down to healthy ligament. The adjacent bone was not grossly involved. The contiguous surfaces of the laminae of the first and second lumbar vertebrae were cut away generously. Autogenous-bone chips from the left ilium were placed over the decorticated surfaces and the patient was immobilized in a plaster body jacket.

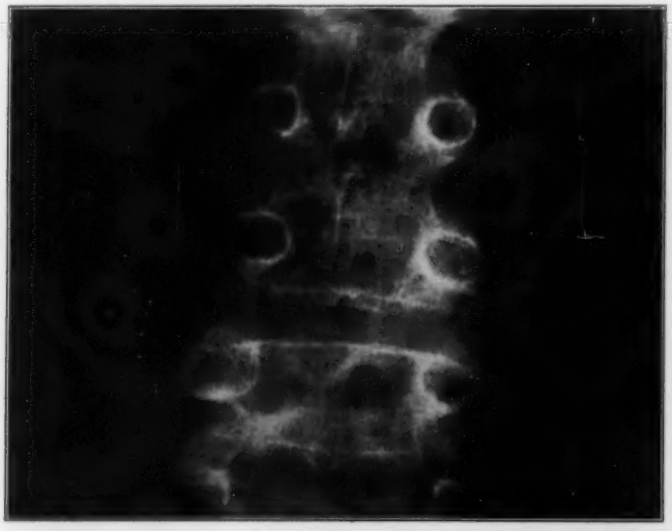

FIG. 3

There is thickening of the left lamina and pedicle of the fourth lumbar vertebra. The arrow indicates an area of increased density with a central area of rarefaction.

Microscopic examination of the tissue suggested osteoid osteoma, but a nidus was not discovered.

After removal of the body cast one month after operation pain and lumbar muscle spasm recurred. The scoliosis increased and, in March 1944, the fusion was extended from the eleventh thoracic to the fifth lumbar vertebra. After operation her spine was held straight by a plaster body jacket. On removal of the plaster in December 1944 her symptoms recurred and the spine curved abruptly above the fusion area.

In July 1945, under roentgenographic control, the thick fusion mass was cut away directly over the interspace between the first and second lumbar vertebrae on the right. Bone structures could not be identified in the solid bone. A cavity was uncovered which contained spongy red tissue similar to that discovered at the first operation. This material lay on the ligamentum flavum and extended into what had been the lamina of the second lumbar vertebra. The abnormal tissue was removed in one piece with a curette. The surrounding bone was then excised widely with gouges and a Kerrison rongeur. The cavity extended to the ligamentum flavum. It was approximately three centimeters in diameter.

A roentgenogram made in the operating room showed complete excision of all bone on the right at the level of the second lumbar lamina. Bone chips from the fusion mass were packed in the defect. Microscopic sections were compatible with osteoid osteoma (Fig. 2).

The scoliosis and all muscle spasm had disappeared in ten days. When last seen two years after operation she had no complaint. On the roentgenogram the spine was straight with a homogeneous fusion mass extending from the first lumbar to the second sacral segment.

Fig. 4: The left lateral view illustrates the guarded stance. Note the lumbar flattening and the flexion of the left hip and knee.

FIG. 4

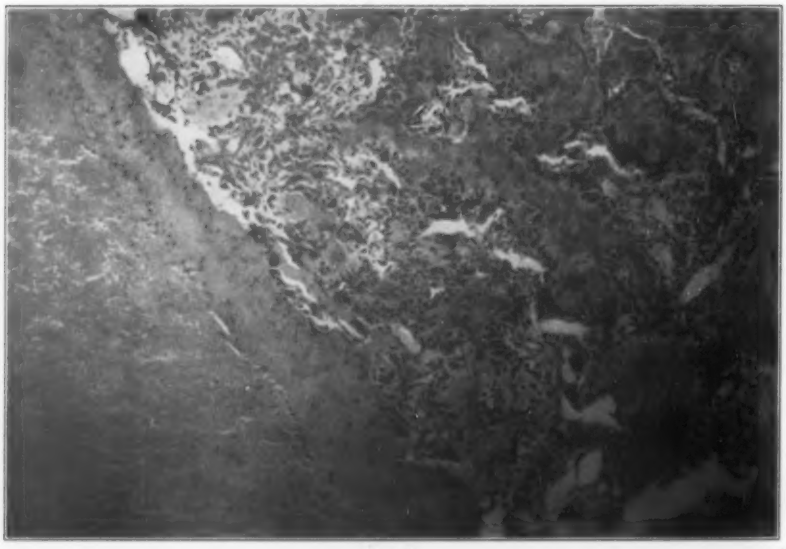

FIG. 5

An area of fibrous tissue and dense bone on the left surrounds the thickened fibrous trabeculae Osteoid formation is apparent in many of the trabeculae (×60).

CASE 2. N. R. This seven-year-old girl was well until November 1958 when she began to limp. One month later pain developed in the low-back region. This pain became increasingly severe, but it was always completely relieved by two and one-half grains of aspirin. The pain was worse at night. In February 1959, her pain extended down the back of the left thigh to the knee, and she began to walk with both hips and knees flexed, more acutely on the left. She was then thoroughly studied at a large medical clinic, and a diagnosis of hysteria was made.

When she was next seen she was so apprehensive that examination was difficult. Bilateral sacrospinalis and hamstring spasm produced a flat back which was associated with a bizarre, stiff, bent-knee gait. There was exquisite tenderness over the left lamina of the fourth lumbar vertebra. Straight-leg raising was 0 degree on the right and 20 degrees less than zero on the left, the left hip being held in 20 degrees of hyperextension when the knee was extended. Attempted straight-leg raising on both sides caused severe pain in the left low back.

Roentgenograms demonstrated a lesion of the left lamina of the fourth lumbar vertebra (Fig. 3), but the existence of this lesion was questioned by most of the radiologists who reviewed the films. A myelogram was negative. On March 20, 1959, biopsy was performed with generous exposure lateral to the facets. The pedicle was exposed by removing the lateral portion of the lamina and the inferior articular process of the fourth lumbar vertebra. A second gouge cut from lateral to medial removed the cortex lateral to the articular process. The cancellous bone of the pedicle was curetted from directly posterior. Only normal cancellous bone was encountered. The left lamina of the fourth lumbar vertebra was grossly enlarged and purple. Its sclerotic posterior cortex was removed along with part of the adjacent inferior articular process. There appeared to be fibrous tissue in the cancellous bone of the lamina. Between the left laminae of the fourth and fifth lumbar vertebrae, the ligamentum flavum was replaced by soft osseous tissue. Excision of this down to the dura revealed no true ligamentum flavum. Microscopic section showed the abnormal interlaminar tissue to be osteoid osteoma.

After operation the pain was partially relieved and there was less hamstring spasm. With activity the muscle spasm and the pain in the back and posterior thigh increased, suggesting that the removal of the lesion had not been complete (Fig. 4).

On April 24, 1959, resection of the inferior half of the left lamina of the fourth lumbar vertebra demonstrated a pearl gray nidus, which was completely excised (Fig. 5). Expansion of the pedicle and articular facet of the fourth lumbar vertebra had compressed the left fifth lumbar-nerve root in the intervertebral foramen and in the spinal canal just medial to the pedicle. The nerve root was retracted and the medial and caudad half of the enlarged pedicle removed so as to decompress the root completely [3]. The articular inferior process of the fourth lumbar vertebra was not disturbed. After operation her pain was relieved completely, and her gait and posture gradually returned to normal. She has remained asymptomatic for more than two years.

DISCUSSION

Since Jaffe defined osteoid osteoma in 1935, thirty-eight cases have been reported [6,7] in the spine. In most of these the diagnosis was not established until exhaustive evaluation had been carried out or until roentgenograms fortuitously demonstrated the lesion. Worse, some of these unfortunate patients were considered to be malingerers or hysterical as was our second patient.

The diagnosis should be suspected from a history of severe localized pain relieved completely by small doses of salicylates. Characteristic physical findings include severe paravertebral and hamstring-muscle spasm with bizarre postural defects.

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Atypical Ewing Tumor in the Sister of a Patient with Ewing's Tumor

Clinical and Autopsy Findings

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We recently reported [2] the case of two sisters with cellular non-bone-forming malignant disease apparently primary in bone. Clinical and postmortem study of the tumor of the younger sister (C.R.M.) indicated that this was a Ewing tumor [1,3,4,5,6,7,8]. The tumor of the older sister (M.J.E.) presented more of a diagnostic problem. The lesion in the radius, treated by amputation in 1953, consisted of relatively large, rounded cells, arranged in groups. Metastatic carcinoma and adamantinomatoid tumor were considered. For five years after amputation, M.J.E. remained apparently free of tumor. In the sixth year, tumor appeared in the right pleural cavity. It was composed of small cells without obvious pattern, and looked very much like C.R.M.'s tumor. Despite the histological differences between M.J.E.'s radial and pleural lesions, it was hard to believe that they were unrelated. The least implausible hypothesis appeared to be that this was Ewing's tumor, primary in the radius, characterized by unusual clinical behavior and by histological features that were extremely atypical in the primary lesion and relatively characteristic in the pleural metastases. At this time, it seems desirable to append the concluding clinical course and the autopsy findings, which were not available when the previous report was written. The additional data fail to suggest any other alternative to the hypothesis of Ewing's sarcoma with unusual clinical and microscopic features.

CLINICAL COURSE

The amputation in September 1953, the thoracotomy in July 1959, and the response of the lesion in the right lower lung to cobalt teletherapy were mentioned in our previous report. (At the autopsy, no viable tumor could be found amid the extensive scar tissue in the right side of the chest.) A metastasis in the left side of the chest was first noted on October 29, 1959 (Fig. 1); it was more obvious on April 14, 1960 (Fig. 2), despite the administration of nitrogen mustard in the interval. Between April 25 and May 18, 1960, x-ray therapy was given through anterior and posterior ports to the left side of the chest, with a total tumor dose of 2,600 r. Marked diminution of the size of the shadow in the left upper lung resulted, as shown on the roentgenogram made on June 20 (Fig. 3). However, despite a dose of 18 milligrams of nitrogen mustard in September 1960, new nodules in the left upper part of the chest were seen on the roentgenogram made on November 15 (Fig. 4). A new shadow, having the appearance of tumor, was also visible in the left lower portion of the chest at this time.

The patient's course was characterized by episodes of fever and pulmonary infection with moderate leukocytosis. Between these episodes, the hemogram was unremarkable, save for mild anemia. At the patient's final admission, she complained of dyspnea and chest pain. The patient died on November 18, 1960, when she was twenty-six years old—seven years and two and one-half months after the amputation and sixteen and a half months after the thoracotomy.

AUTOPSY FINDINGS

A complete autopsy was performed on November 18, 1960. There was extensive pleural and

FIG. 1

FIG. 2

Roentgenogram made on October 29, 1959, showing the infiltrate in the left upper part of the chest.

Massive infiltrate in the left upper part of the chest is visible on this roentgenogram made on April 14, 1960. The patient had received nitrogen mustard since the previous October.

FIG. 3

FIG. 4

Roentgenogram made on June 20, 1960, showing clearing of the shadow in the upper left part of the chest after irradiation.

The final roentgenogram, made on November 11, 1960, shows the density in the lower left part of the lung.

pulmonary fibrosis on the right, with bronchiectasis and foci of pneumonitis in both lungs. The tumor was confined to the left chest cavity; it was composed of a large disc-shaped mass, twelve centimeters in diameter, attached to the lower ribs, and numerous nodules on the pleural surface of the lung. Meticulous search of other organs and tissues revealed no foci of tumor and no other significant abnormalities. The adrenal glands were grossly and microscopically unremarkable. The

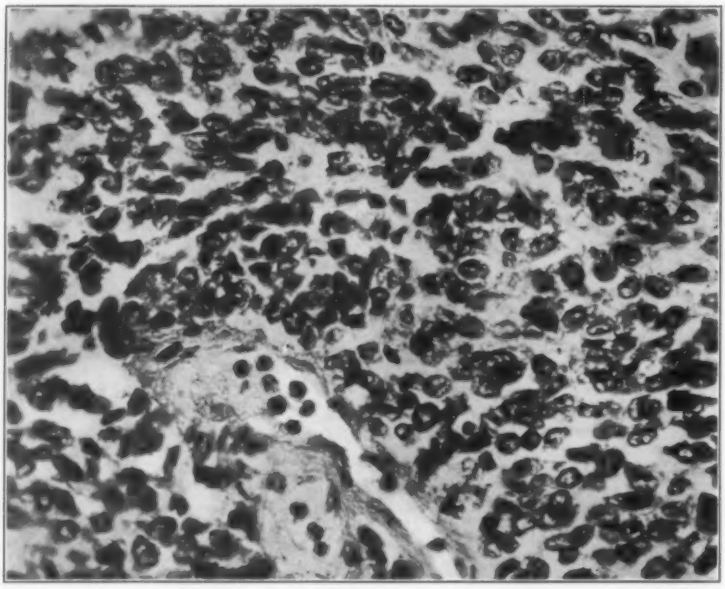

FIG. 5

Tumor from the left pleura at autopsy (× 500).

vertebral bone marrow was active and cellular without obvious abnormalities. Anatomical diagnoses were: metastatic Ewing's sarcoma of the pleura, radiation pneumonitis, bronchiectasis, and acute and unresolved bronchopneumonia. Pulmonary insufficiency was considered the cause of death. The tumor tissue was soft and light gray, with areas of hemorrhage and necrosis. Microscopically, it exhibited the small-cell patternless structure of the specimen obtained at thoracotomy in 1959 (see Fig. 2-D in the previous article [2]). Its histological characteristics were in sharp contrast to the groups of larger cells found in the radial lesion (see Fig. 2-B in the previous article [2]).

SUMMARY

In a previous report [2] of two sisters with bone tumors, we suggested that one tumor (C.R.M.'s) was a typical Ewing tumor and that the other (M.J.E.'s) a most unusual Ewing tumor. We present here the concluding clinical course and the autopsy findings in the case of M.J.E. The metastatic lesion in the right side of the chest had responded to irradiation. At autopsy, there was a good deal of tumor in the left side of the chest and none elsewhere. Nothing was found to suggest lymphoma, neuroblastoma, or small-cell carcinoma. We are unable to suggest a reasonable alternative to the hypothesis that this was an atypical Ewing tumor.

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Onchocerciasis of the Hand

Report of a Case

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A Negro laborer, fifty-two years old, was seen for the first time at the Veterans Administration Research Hospital, Chicago, Illinois, on February 28, 1959, complaining of a tender nodule on the ulnar aspect of the left palm. He had first noted this mass nine years before and reported that periodically it had become more prominent and tender. During one of these episodes, the mass was incised by another physician, but no pus or foreign body was found.

The patient presented himself for treatment because the mass had become chronically tender and interfered with his work. The only additional complaint was the presence of paresthesia in the little finger of the same hand, noted when the mass was most tender.

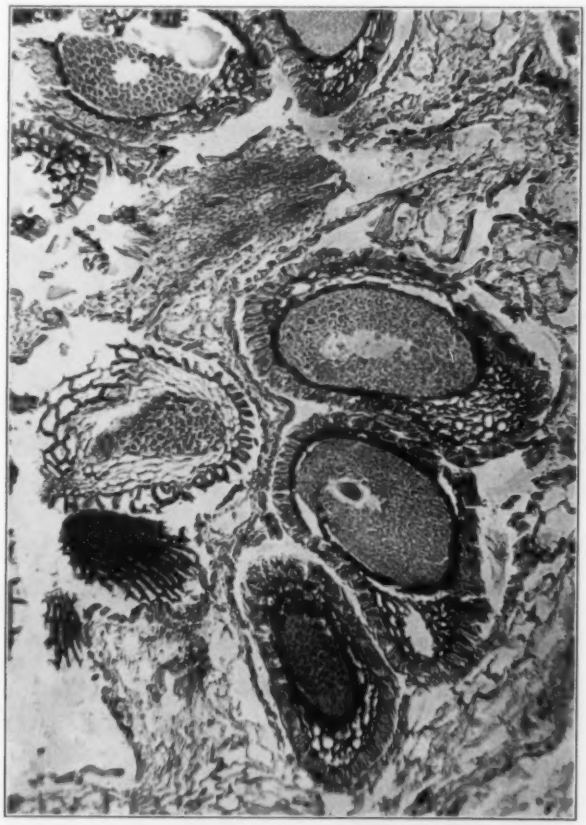

FIG. 1

Vascular connective-tissue stroma containing a convoluted parasitic worm cut in cross section (× 18).

The patient had served in the Navy in Burma and India and also in South Africa during World War II.

Physical examination was entirely within normal limits, with the exception of a firm, tender, ovoid mass, two centimeters by one centimeter, near the middle of the left hypothenar eminence. The skin over this mass was thickened and calloused. The mass itself was slightly movable on the deep fascia, and the skin was questionably movable over the mass. There was no sensory or motor deficit in the hand, nor was a Tinel sign elicited over or around the nodule. No other subcutaneous nodule was palpable.

The laboratory findings were as follows: The total leukocyte count was 8,700, with a differential not reported. The hematocrit was 47.5 volumes per cent; the hemoglobin was 15.4 grams per 100 cubic centimeters; and the sedimentation rate (Wintrobe) was twenty millimeters per hour. Routine urinalysis and roentgenograms of the chest were within normal limits. Roentgenograms of the hand revealed a soft-tissue mass over the left hypothenar eminence, with no evidence of bone or joint disease. The preoperative diagnosis was fibroma.

Under brachial-block anesthesia with a tourniquet for hemostasis, the palm was explored through a two-inch transverse incision parallel to the proximal flexion crease. The mass was found to lie in the deeper portion of the subcutaneous tissue adherent to the fascia over the hypothenar muscles and in close proximity to the superficial branch of the ulnar nerve. It was soft and blue in color, resembling a mass of tangled vascular channels. The mass also had a prolongation that extended under the ulnar border of the palmar fascia. The palmar fascia was divided, and the entire mass was excised without any damage to the surrounding structures. The patient's postoperative course was uneventful.

FIG. 2

A longitudinal view of a smaller nematode. Note the cuticular ornamentation, with conspicuous transverse annular thickenings (× 30).

Microscopic sections of the excised tissue showed a vascular connective-tissue stroma that contained a convoluted parasitic worm (Fig. 1). Cross-sections of several segments of the worm contained microfilariae. A side view of a smaller nematode (Figs. 2 and 3) showed the striking cuticular ornamentation with conspicuous transverse annular thickenings that are characteristic of this worm.

Onchocerciasis, also known as onchocercosis, is not a rare disease in Africa and Central America. The disease is caused by infestation with the roundworm, *Onchocerca volvulus*. The buffalo gnat, *Simulium damnosum*, serves as the vector and intermediate host in Africa. In Central America, other simuliidae are vectors. In man, the incubation period between infestation and clinical manifestation varies from four months to a year. Apparently, man is the only definitive host. Microfilarial forms are injected with the gnat bite, develop into larvae, and then into adult forms, which, in turn, discharge microfilarial forms into the tissue fluids. Microfilarial forms have never been found in the peripheral blood; usually, they are found in microscopic sections of the dermis or conjunctiva.

In highly endemic areas, the majority of the human population may be infested. The most persistent clinical manifestation is the presence of subcutaneous nodules; these may be single or multiple. In one large series [4], the majority of

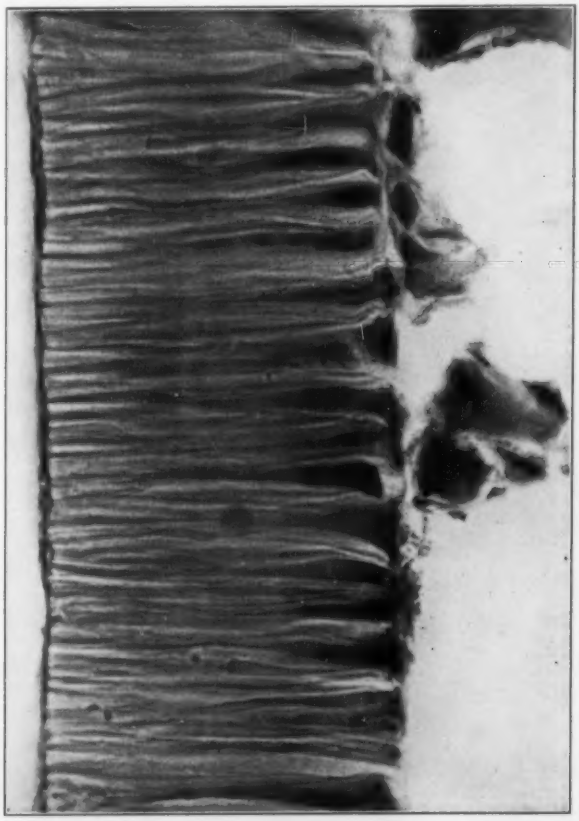

FIG. 3

A side view of the nematode at higher magnification (× 350). The cuticular ornamentation is striking and characteristic.

nodules were located in two anatomical sites—the rib cage and the pelvic girdle. Apparently, there is no relationship between the site of bite and the location of the clinical tumor. We have been unable to find a previously reported case of a nodule in the hand.

The typical lesion is a non-suppurative fibrous tumor that develops as an insulating membrane around the adult worm. The nodules range in size from several millimeters to several centimeters in diameter. They are hard to palpation, but are often cavernous and usually contain at least one pair of male and female worms inextricably tangled in a fibrous matrix and bathed in free fluid containing microfilariae.

Dermatological and ocular manifestations occur; the latter are the most disabling aspects of the disease.

There are no known effective chemotherapeutic agents; surgical excision of the nodule is the accepted diagnostic and therapeutic procedure.

SUMMARY

A case illustrating an unusual cause of subcutaneous tumor of the hand has been reported.

To our knowledge, the occurrence of a nodule of onchocercosis in the hand has not been previously reported in the literature.

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An Unusual Vertical Fracture of the Fifth Lumbar Vertebra

Report of a Case

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The purpose of this brief case report is to place on record the occurrence of a fracture of a very unusual kind of the fifth lumbar vertebra.

J.X., about thirty-five years old, a male Bantu laborer, six feet tall and of excellent physical condition, sustained a direct blow on the thoracolumbar region of his back from a rather heavy falling object. He was struck to the ground and rendered nigh unconscious. There were language difficulties which made it impossible to ascertain details, but his complaint of very severe pain in his back at the time of examination was readily understood, and his agony was plain to see. There

Fig. 1-A

Fig. 1-B

November 3, 1958

was extremely acute tenderness over the lumbar spine extending from the lower thoracic region of the back downward to the sacrum. All active movement of his spinal column was inhibited, and attempts at passive movement were resented. A fracture or fractures of one or more lumbar vertebrae was diagnosed. The roentgenographic examination confirmed the provisional diagnosis, but revealed an unusual kind of fracture. The body of the fifth lumbar vertebra was completely split in the coronal plane, with the split located at the junction of the posterior two-thirds and anterior one-third of the body. Although the fracture appeared to be complete, fragments were minimally displaced. The roentgenograms also showed that both twelfth ribs were fractured near their vertebral ends. The roentgenologist reported that in the body of the fifth lumbar vertebra there

was an unusual, vertebral, irregular, translucent defect which did not have the appearance of a fracture, and that there was a fracture of both twelfth ribs in their posterior portions. Despite this indefinite report, the history and clinical evidence left no doubt in my mind that the bone defect was of traumatic origin and a very real fracture; treatment appropriate to this diagnosis resulted in considerable relief of the man's suffering. A second roentgenographic examination, five days after injury, was interrupted by the roentgenologist as showing a defect in the fifth lumbar vertebral body that was very suggestive of a fracture, although this fracture might be of some standing. Four months later the roentgenologist observed that the fracture of the fifth lumbar vertebral body was still clearly discernible. Healing by bone union had not appeared, although the patient's symptoms had gone completely. Two months later, after the patient was allowed full usual activity without weight-bearing upon his back or shoulders, he admitted to no residual symptoms.

Two years to the month after the injury a follow-up roentgenographic study of this patient's fifth lumbar vertebra was carried out by Dr. Robin Fouché, using straight roentgenograms and serial tomographic sectioning of the body of the vertebra. He noted that the tomogram demonstrated that there had been a fracture in the coronal plane through the middle of the vertebral body, with the formation of depressions in the superior and inferior surfaces of the vertebra. The depressions in the vertebral plates were observed to extend from one centimeter to the right of the mid-line to at least two centimeters to the left of the mid-line. The right lateral rim of the vertebral body on both the superior and inferior aspects of the body was thus intact, and there was probably also a rim of undepressed bone over the left lateral aspect. The depression was thus shown to be centrally placed within the circumference of the vertebral body, extending along the coronal plane.

FIG. 2-A

FIG. 2-B

August 31, 1960

COMMENT

Comparison of the roentgenograms made shortly after injury (Figs. 1-A and 1-B) and at follow-up (Figs. 2-A and 2-B) establishes that healing of the fracture had taken place, but the healing had been incomplete. Also shown clearly is the collapse of the superior end-plate of the fifth lumbar vertebra that took place during the interim. The height of the disc space between the fourth and fifth lumbar vertebrae, however, has not been noticeably diminished. The dynamics concerned in the production of this vertical coronal fracture of the body of the fifth lumbar vertebra are not wholly clear. It has been suggested that hyperflexion or vertical loading of the spine may fracture the superior vertebral plate of the vertebra and cause the nucleus pulposus to be driven into the substance of the vertebral body, thereby splitting it in the coronal plane. Figures

1-A and 1-B suggest that there is a crack in the posterior part of the superior vertebral plate of the fifth lumbar vertebra and, possibly, some downward displacement of the central portion of the plate. The later tomograms served to confirm this displacement. Perey, in his monograph, illustrates an experimentally produced fracture somewhat resembling the one reported here. This experimental fracture was produced by dynamic vertical loading of a section of lumbar spine, but the traumatic dynamic loading of the lumbar spine in the case reported here cannot be considered strictly comparable with Perey's experimental conditions, even though the fractures are similar. As a result of his investigations, Perey was able to separate the types of fractures he produced into three groups. It is in his Group III that the fracture here presented could be placed. In this group the fracture was in the coronal plane, and extended as a fissure through the vertebral end-plate. When it deepened to involve the rest of the vertebral body, dividing it into two parts, there was little or no displacement of the fragments. Typical compression fractures were excluded from this group.

It has also been suggested that hyperflexion of the lumbar spine with slight backward displacement of the fourth on the fifth lumbar vertebra might cause the antero-inferior corner of the body of the fourth lumbar vertebra to focus stress in the region of the fracture and so produce the vertical split shown by the roentgenograms.

The history of the accident pointed clearly to the application of a sudden and direct force to the thoracolumbar region, powerful enough to render the workman almost senseless. The fresh posterior fractures of the twelfth ribs would be produced by such violence. Of the various types of fracture to which the spinal column is liable, the most comparable one is the vertical fracture through the body of a cervical vertebra, but this is usually in the sagittal plane. Sicard and Godet portrayed beautifully the types of fractures of the lumbar vertebrae. They made no mention, in their survey, of the kind of fracture reported here.

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Trauma and the Orthopaedic Surgeon*

BY EDWIN F. CAVE, M.D., BOSTON, MASSACHUSETTS

We are meeting for the second time at "Grizzly Bear", the name of the Indian tribe from which Yosemite got its name in 1851. The Association first met here under the Presidency of J. T. Watkins in 1927. Watkins' presidential predecessors, who were pioneers in orthopaedic surgery in the Far West, were George B. Packard of Denver, an original member of the Association, and Harry M. Sherman, who was elected to membership in 1889. Warren White's Presidential Address in 1955 detailed the development of Western orthopaedics as to personnel, hospitals, and medical schools. The Western Orthopedic Association, an organization of more than 700 members, has played a vital role since 1932 in the development of orthopaedic surgery in this part of the world.

To the Western Orthopedic Association, and particularly to the local Western Committee and their wives, I express my profound thanks for their tremendous contribution to this meeting.

The founding of our organization was preceded only by that of the American Medical Association in 1847, the American Surgical Association in 1880, the American Clinical and Climatological Society in 1884, and three specialty groups: ophthalmology, otology, and gynecology. Many have followed; most of them larger, but none more select than ours. This selectivity carries with it a strong obligation. Election to The American Orthopaedic Association does not mean that we have reached the top and can rest—quite the opposite. It indicates added responsibility in directing the teaching and practice of orthopaedic surgery in North America and influencing it to a considerable extent throughout the globe.

This is the Seventy-fourth Annual Meeting of the oldest orthopaedic society in the world. Our organization has met annually since its founding, except in the year 1945, marking the end of World War II.

Of our Canadian membership, which began in 1906 with the election of B. E. Mackenzie, we can be justly proud. Mackenzie has been followed by a list of distinguished surgeons north of the border, all of strong character, ability, and accomplishment. Six of those men have been President of the Association. This friendship and association with Canadian orthopaedic surgeons will be preserved. It benefits all of us. We may predict, also, that Latin American membership in our Society will increase to our advantage.

In 1887, fifty-five million people lived in the United States and four million in Canada. Both countries were prospering. President Cleveland was serving his first term. In England, Queen Victoria presided at the opening of Parliament; and, in Germany, Bismarck spoke forcibly in the Reichstag, stating: "Our friendship with Russia is beyond doubt and we shall never attack France". Henry Ward Beecher, preaching in Brooklyn, remarked: "I would have been a Democrat were it not for the Democratic Party". Lillian Russell was performing in Boston, and John L. Sullivan had broken his carpal navicular on striking the back of the neck of an opponent. Florida lots of 5,000 square feet could be bought for $10.00, and custom-made pantaloons sold for $5.50.

These were some of the happenings in the year of the founding of our Society. Our organization has witnessed the extraordinary growth of America since 1887.

* Presidential Address read at the Seventy-fourth Annual Meeting of The American Orthopaedic Association, Yosemite, California, May 24, 1961.

Our country has been through six economic crises, two of them major ones; we have survived four wars.

1887—forty-one years after the first public demonstration of the use of sulphuric ether for anesthesia, thirty years after Pasteur's epoch-making investigations, twenty years following Lister's great discovery, and nine years prior to Roentgen's contribution of the x-ray. All of these great advances revolutionized surgery in all forms and made possible the development of the surgery of our specialty, which was due to come some years after the actual founding of our Society.

The name of our branch of surgery certainly does not describe it adequately, nor does it indicate that trauma has any place at all in our specialty. Baer in 1924 wrote: "It occurs to me that our specialty may be somewhat handicapped by its name. Perhaps the word 'paidos' is the cause". But we ask ourselves, would we or can we give up the name of orthopaedics or orthopaedic surgery? Of course not. By those names our specialty has been designated since Andry coined the word *orthopédy* in 1741.

Early in the existence of the Association an awareness of the importance of trauma as a part of orthopaedic surgery was shown when in 1894 Phelps observed: "It is my earnest conviction that within a very few years fractures and dislocations will be treated by the orthopaedic surgeons". In 1906 Mackenzie of Canada expressed concern that orthopaedic surgeons were not taking their full responsibility in the management of trauma.

Actually, however, orthopaedic surgery was reborn and expanded during and after World War I, largely because trauma to the extremities became a part of orthopaedic surgery for the first time. In fact, many members of this Association were made by their war experience. Some had no formal training as we know it today, but after World War I contributed greatly to the development of the specialty in the years to follow.

Outstanding in the development of the traumatic side of orthopaedic surgery in World War I were Goldthwait, Osgood, Allison, Leo Mayer, and Gallie; also Porter and MacKenzie Forbes, who were successively Presidents of the Association during the war years 1917–1918. Of the younger group who gained vast experience during the first great war and who later rose to eminence in their specialty were Frank Dickson, Key, Ober, Wilson, Abbott, Smith-Petersen, Harris, Robertson, Lewin, James Dickson, and Ghormley, to name just a few.

Porter in his presidential address in 1917 stated: "I believe a new era has begun for our specialty through the impetus given by war. The old conception of orthopaedic surgery is undergoing transformation rapidly".

In 1919, Galloway wrote: "The war has done more to bring orthopaedic surgery into its true inheritance than would have been accomplished by any other agencies in many years".

Although the traumatic side of orthopaedic surgery was greatly reinforced by experience in World War I, relatively few orthopaedic clinics throughout our country had the privilege of caring for fractures and other trauma after the war of 1914–18; at best, they shared the management of extremity trauma with the general surgeons. In a few established fracture clinics the orthopaedic surgeon was usually an associate chief or a consultant. More frequently than not, the efforts of the orthopaedic services were confined to the management of joint fractures, ununited or malunited fractures, and minor fractures which did not involve soft parts.

World War II changed all of this. The sections of orthopaedic surgery in military hospitals often represented the largest divisions on the surgical services.

Surgical teams sent to the forward areas were staffed by orthopaedic surgeons as the supply would allow. Wounds of the extremities made up 70 per cent of the case load of evacuation hospitals. If the development of orthopaedic surgery was enhanced by World War I, it was expanded tenfold by the experience gained in the War of 1939–45, thanks in no small measure to one of our members, the late Major General Norman T. Kirk, who was at that time the Surgeon General of the Army. All spine and extremity surgery came more and more under the care of the orthopaedic surgeon, including surgery of the intervertebral disc, hand surgery, certain forms of plastic surgery to the extremities, and certain problems of vascular and peripheral nerve surgery.

Believing with Winston Churchill that the farther we look back the better we see forward, let me review briefly what I consider to be the seven great accomplishments of The American Orthopaedic Association before glancing to the future of some aspects of the changing times in orthopaedic surgery.

First, The Journal of Bone and Joint Surgery, which was published originally as the *Transactions of The American Orthopaedic Association* in 1889. In 1903 the title was changed to *The American Journal of Orthopaedic Surgery*, in 1919 to *The Journal of Orthopaedic Surgery*; in 1922 to its present title, *The Journal of Bone and Joint Surgery*. It began its association with the British in a joint publication in 1948. Of the seven editors since its beginning, Elliott Brackett and William Rogers should be singled out. They presided over this very important part of our orthopaedic lives from 1921 to 1958—thirty-seven, or just half, of our seventy-four years.

Second, the thesis. The candidate's thesis as a requirement for membership was inaugurated in 1893 at the suggestion of Steele, then President of the Association. It continued in effect until just before World War II. The vote to eliminate the thesis at that time was by no means unanimous, however, and it was reinstated in 1955. Certainly, it has made possible a more effective evaluation of candidates and has been a great stimulus to the authors. This Association has within its ranks nearly everyone responsible for the future direction of teaching and practice of orthopaedic surgery in North America. Those who join the Association must have the highest qualifications in research or in practice and teaching. Restoration of the thesis is directed toward these ends.

Third, The American Academy of Orthopaedic Surgeons, founded in 1931 by Henderson, Gaenslen, Campbell, Ryerson, Orr, Lewin, and Mumford, all members of The American Orthopaedic Association. It is a vigorous organization, the Academy, the largest of its kind in the world, with a membership of approximately 3,000. It is for orthopaedic surgery what the American College of Surgeons is for surgery in general. The contributions of the Academy have been outstanding. The Instructional Courses, initiated by J. E. M. Thomson in 1941, have set the pattern for this type of postgraduate teaching in American surgery and have been copied by the American College of Surgeons and other specialty groups. One of our members has designated our Association as *the Senate* and the Academy as *the House*. They can work hand in hand. Each serves its function. Our obligation as the senior group is to aid and abet the activities of the Academy.

Fourth, the Exchange Fellowship Program. This exchange of visits between young American, British, and Canadian orthopaedic surgeons was inaugurated in 1948 at the suggestion of Robert Harris of Toronto. In 1948, thirteen Fellows came to our country and to Canada. In 1949 a similar group from Canada and the United States traveled to Great Britain. After that the number was reduced to a total of five, four from the United States and one from Canada; from the British Commonwealth, four from the British Isles and one from either South Africa,

New Zealand, or Australia. Since the initiation of this program more than eighty Fellows have benefited by the exchange. These ABC men will exert a profound influence upon orthopaedic surgery throughout the world.

Fifth, the Manual of Orthopaedic Surgery, recently revised and reprinted, was conceived in 1952 by Fremont Chandler. It fulfills a need in orthopaedic surgery as do the Fracture Manual and the Soft Tissue Manual of the American College of Surgeons.

Sixth, The Orthopaedic Research and Education Foundation, incorporated in 1955 under the leadership of A. R. Shands, Jr., has done more to stimulate financial support for research in orthopaedic surgery than any other endeavor in the life of the Association.

Lastly, but not the least important, The American Board of Orthopaedic Surgery. God bless the Board! What abuse it takes! It has been said that if the American College of Surgeons, founded in 1913, had been more careful in the selection of its members in the early years of its existence, there would have been no necessity for specialty boards. Be that as it may, this method of evaluating surgeons in all specialties is firmly established. The American Board of Orthopaedic Surgery, originally made up of nine members of this Association, has performed admirably during its twenty-seven years. Having been a regular member or an alternate member of the Board for the past thirteen years, your President can appreciate its shortcomings as well as its attainments. I would make the observation, however, that the tendency of some members of the Board and some other outstanding orthopaedic surgeons has been to narrow our specialty too much and to isolate us from our colleagues in other branches of surgery. In many previous Presidential Addresses, the requirement for broad, preliminary training in surgery in general has been emphasized. Badgley wrote, "Our aim should be first, to train doctors; second, to train surgeons; and then to train orthopaedic surgeons", and Abbott said, "Specialists in the same surgical field are not for long the best company for each other".

Recently, an effort has been made to evaluate the activities of orthopaedic surgery, particularly in regard to the management of trauma, basing our opinions on replies from eighty-three directors of orthopaedic training centers. A 100 per cent response was obtained.

And now I must give some figures: The Emergency Ward was the subject of the first question. Sixty-four of eighty-three replies (77 per cent) indicated that general surgeons are in charge of emergency wards. This compares with Stewart's report before the Southern Surgical Society in 1959, when he summarized the results of his studies of emergency wards in 271 hospitals. He found that 84 per cent were being directed by general surgeons. In his survey, however, 41 per cent of emergency-ward admissions had traumatic lesions, whereas only 5 per cent of the total admissions had non-traumatic, acute abdominal disease.

Eighty-one of eighty-three of our replies stated that fractures are largely in the hands of the orthopaedic surgeons. Thirteen indicated that general surgeons are treating fractures in their clinics. The majority of skin grafts are being done by plastic surgeons, but second in this endeavor are the orthopaedic surgeons. In eighty-one clinics amputations are done by orthopaedic surgeons; in sixty-three of these they are shared with the general surgeons. Tendon surgery is done by orthopaedic surgeons in seventy-three centers, by general surgeons in sixty-one, and by plastic surgeons in twenty-five. In seventy-four of the eighty-three installations, hand surgery is done by orthopaedic surgeons; in forty-four by general surgeons; and in thirty-three by plastic surgeons. Directors of twenty-two training centers reported that they had separate hand services.

A significant observation was that children's orthopaedics in relation to trauma is decreasing. Seventeen installations replied that this was definitely so, and another twenty-one stated that there was a relative increase in fractures and other trauma. This impression is substantiated by figures from one Shriners' Hospital, which showed that in 1925 there were 49 per cent cases of poliomyelitis and in 1957 only 12.4 per cent. Tuberculosis decreased from 5.9 to 1 per cent. Mental defectives, cerebral palsy cases, etc. increased from 1.8 to 12.0 per cent and congenital deformities increased from 6.3 to 24.4 per cent. "Accidents to children remain the leading cause of death in the younger groups—perhaps not so much because of any great actual increase in accidents as because of the continued decrease in deaths from infectious disease." The fact is that trauma is now the commonest cause of death under the age of thirty-six years in the United States.

Curtis, in a review of forty-eight children's orthopaedic installations, concluded that ten years ago these installations were almost entirely devoted to orthopaedics. Now, 25 per cent of the work in these facilities is carried on by other specialties and at that only three-fourths of the beds are occupied. Curtis also found that where there is a large concentration of population, children's orthopaedics has dropped remarkably, and adult services have increased. Serious consideration is being given to a trauma service in many of the installations included in Curtis's survey.

Fortunately, there is still a desire on the part of the vast majority of orthopaedic centers to require for the trainee preliminary training in basic surgery. Forty-eight of the eighty-three in our study believe that one year of general surgery is sufficient; twenty-six prefer two or more years; and only five are of the opinion that preliminary surgical training prior to specializing is unnecessary. In this connection a Committee from the Council of Medical Education and Hospitals, the American Board of Surgery, and the American College of Surgeons is making an effort to provide a minimum of two years of basic surgical training for the surgical specialties. It is proposed by them that two years as an assistant resident in general surgery be a prerequisite for acceptance into any training center for a surgical specialty. I am sure that the real hope is to raise the standards of all branches of American surgery. Frank Glenn has remarked editorially: "The success of such a plan would be dependent upon a complete understanding of the objectives and an unreserved, dedicated co-operation upon the part of the general surgeons and those in the surgical specialties". I suggest that members of The American Orthopaedic Association and other qualified orthopaedic surgeons join in this effort and insist that adequate, basic, surgical training for the specialist be provided by the general surgical services in our country. This point of view is not inconsistent with maintenance of our independence and a demand for a stronger voice in directing the departments of surgery in our medical schools, as was so vigorously advocated by Abbott in 1947.

The majority of us are primarily surgeons. Our patients are the first to insist that we know what we are doing and that we do it properly when they are on the operating table and during their postoperative care. Our research laboratories in orthopaedic surgery are gradually increasing in number and in quality. The need for basic research is fundamental. The Orthopaedic Research and Education Foundation deserves strong praise. We do not yet have in our ranks, however, a sufficient number of men adequately trained to instruct our younger members in broad, basic, surgical principles, not so much in techniques—we can provide that—but in the knowledge of wound healing, the treatment of shock, the role of the endocrines, fluid balance, and of total preoperative and postoperative care.

Naffziger, himself a neurosurgeon, has remarked: "Specialization is essential

to progress but to be useful as a teacher the specialist must be able to investigate his work in the entire field of surgery".

Next to obstetrics and gynecology we represent the largest single specialty group in surgery. The proposal to establish a Board of Trauma was correctly opposed in 1957. Nevertheless, such an occurrence will be a possibility unless we as orthopaedic surgeons equip ourselves in order to cope with the problem of trauma in a general sense.

One may ask how this can be accomplished with our present requirements in medical schools and in postgraduate training. Time in postgraduate training cannot be sacrificed. Where, then, can we economize on time? It must be done in our colleges and in our medical schools. This can be done without sacrificing training in basic science. A graduate of a college may go directly to business and, as a rule, work eleven or eleven and a half months a year. Medical students are not engaged in required study for twelve months out of the forty-eight in their course of instruction. Is it not time that medical-school curricula be altered to meet the needs in post-graduate training? R. A. Moore, President of the Downstate Medical Center of New York, suggests elimination of the summer vacation and an acceleration of the program for brighter students. Some experimentation in this regard is under way at Western Reserve, Johns Hopkins, and Northwestern Medical Schools. Boston University is combining in six years, training in liberal arts and medicine, and is utilizing the summer months in so doing. In these changing times we find ourselves as did those famous cartographers, Rand and McNally, after World War I, when maps were constantly changing according to the wishes of those recorded as victors. In the words of Newman Levy:

" 'Time was when this business of ours was grand,'
Said Mr. McNally to Mr. Rand,
'When our toughest job was to sit and think
Shall France be purple and Britain pink?
Shall Spain be tinted a bright cerise,
And perhaps a dash of green for Greece?'

* * *

'Remember those days,' McNally said,
'When we'd plan a map a month ahead,
And we'd know, if it came out at noon, let's say,
It was up to date the entire day?'

* * *

'Those days,' said Rand, 'are gone *totally*.'
'You said it, brother,' said Mr. McNally."

While much has been accomplished in caring for the injured patient throughout our land, and while many individual orthopaedic surgeons have done their part, our societies of orthopaedic surgery have done little as organizations toward this end. The Instructional Courses of The American Academy of Orthopaedic Surgeons provide an excellent source for the teaching of trauma to the younger orthopaedic surgeons, yet in 1960 of a total of 111 courses given, only twenty-one dealt with fractures and other forms of trauma, and all but four of these had to do with injury to bone alone. With the relative decrease in children's orthopaedics and an increase in trauma, should there not be some realignment in the residency training of orthopaedic surgeons?

The British orthopaedic surgeons are a step ahead of us in trauma management. Worth noting is the *Memorandum on Accident Services—1959*, published by a committee representing The British Orthopaedic Association. The situation in

Britain where the population is concentrated is admittedly bad. It is far worse in our land where distances are greater, and adequately trained personnel to care for the wounded are widely scattered.

The American Orthopaedic Association has taken the lead in advancing orthopaedic surgery throughout its seventy-four years. I think, however, we have not put forth our best effort toward the injured patient. Let us pick up the challenge and adopt a positive attitude toward the necessity of greater participation in the management of trauma. We must be aggressive in our approach. We must be the leaders. Said Pericles to the Athenians: "We do not imitate—but are a model to others". Whether we like it or not, the care of the wounded has fallen upon our shoulders. We can no longer simply sit as consultants. Theodore MacManus wrote:

"Man was not made to sit a-trance,
And press, and press, and press his pants;
But, rather, with an open mind,
To circulate among his kind.

"And so, my son, avoid the snare
Which lurks within a cushioned chair;
To run like hell, it has been found,
Both feet must be upon the ground."

Realizing that three-fourths of all trauma is to the skeletal system, I believe frankly that we as orthopaedic surgeons are not responding sufficiently to our opportunity and responsibility in the management of trauma. Mitchell expressed the same feeling in 1959 when he insisted that greater emphasis be placed upon training in all phases of trauma to the trunk and extremities.

I am convinced that the future of orthopaedic surgery will lie to a great extent in the field of trauma.

Many conditions which the orthopaedic surgeon has treated in the past can and should be prevented or corrected early in their development; namely, congenital dislocation of the hip, club-foot, and, possibly, scoliosis. At a meeting of the International Society of Orthopaedic Surgery and Traumatology held in New York in 1960, a day and a half was spent discussing congenital dislocation of the hip. Perhaps a more appropriate audience would have been that of obstetricians and pediatricians. Certainly these two specialty groups must bear a heavy responsibility in detecting congenital anomalies early in life, when treatment is relatively simple.

Bryan McFarland in his *Editorial of A.D. 2000*, which, after all, is only thirty-nine years away, wrote: "The incidence of bone and joint injury has increased and today we pay respect to the gallant efforts of our forefathers who perforce spent so much of their time in treating congenital dislocation of the hip, clubfoot, and other deformities that are seldom seen today except in museums". Let us hope this day will come.

In closing my remarks, I like to remember that William T. Councilman, Professor of Pathology at Harvard, in his last formal lecture in 1922, referred to the three great epochs of life as birth, marriage, and death. A fourth great epoch in the life of any orthopaedic surgeon would surely be that of Presidency of this great Society.

I recall my predecessors in this office with admiration, and when I think of my teachers I am more than grateful; to Nathaniel Allison, who first encouraged me to study orthopaedic surgery; to Ralph Ghormley, whom I revered all of my

professional life; and to my chief, Marius Smith-Petersen, that unique and stimulating character, whose contributions to our special branch of surgery will live forever, and who taught me so much.

Preparing for this meeting has been a stimulating and exciting task; but, actually, my associates on the Executive Committee have done the work. They have provided the thrust to get the meeting off the launching pad.

I thank the hard-working committees of the Association, particularly the Program and Membership Committees, and to my fellow officers of the past year, especially to our Secretary, Ramsay Straub, who is a tower of strength on any man's team, I express my warmest appreciation. To the entire membership of this senior association of selected American, Canadian, and Latin American orthopaedic surgeons, for the great honor that you have given me, I thank you.

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Proceedings

THE AMERICAN ACADEMY OF ORTHOPAEDIC SURGEONS

SCIENTIFIC EXHIBITS — 1961

A Team Approach in Prosthetics and Orthotics in the United States. LESTER A. SMITH [1], Asst. Director of the American Board for Certification in Orthotics and Prosthetics, Inc., HOWARD THRANHARDT, and RICHARD BIDWELL said that of the many characteristics that typify prosthetics and orthotics in the United States today, three are outstanding. They may be generically described as: (1) the team approach, (2) the concern with the individual patient, and (3) total rehabilitation. Although these three elements in the treatment of the disabled can be discussed as separate entities, in actual practice they are rightfully treated as one. The team acts as an integral unit to help the individual paralytic or amputee to achieve total rehabilitation and each element is indispensable to the success of the other two.

Basic research is conducted to provide efficient substitutes for lost functions. Before adequate substitutes can be found to replace lost functions the original, natural functions must be studied and understood. How does a man walk? Once that question is properly answered the problem of imitating his walk with an artificial device has some direction. Since a variety of professions are involved in any basic research, the fundamental work must be performed where there is a variety of talent. In this case the universities are ideal. The University of California at Berkeley and San Francisco has taken on the basic research involving lower extremities. The University of California at Los Angeles operates a laboratory to conduct fundamental research on upper extremities for amputees. The University of Michigan conducts basic research on upper extremities with relation to orthotics. Coordinated through the Committee on Prosthetic Research and Development of the National Academy of Science National Research Council, the work of these universities is financed by the Office of Vocational Rehabilitation, The National Institutes of Health, the Veterans Administration, the National Foundation, the Society for Crippled Children and Adults—Easter Seal Foundation, and other public and philanthropic agencies.

Creative development is used to fabricate the devices and for nulate the methods developed from criteria established in basic research. These functions are performed by engineers, prosthetists, and orthotists. Testing is constant during development to ensure safety and usefulness. Among the organizations engaged in the development of devices and techniques are the Veterans Administration Prosthetics Center, Army Prosthetics Research Laboratory, Navy Prosthetics Research Laboratory, Mauch Research and Development Laboratory, The American Institute for Prosthetics Research, Rancho Los Amigos Hospital, the University of California, and Northwestern University, among others. A number of private limb and brace manufacturers are engaged in a limited amount of development. New York University is responsible for the major portion of the evaluation required before the item is released for general use.

There is a constant inter-relation between the basic research and creative development areas of the prosthetics and orthotics program. The result of basic research in creative development is an array of devices and techniques for meeting the individual needs of many different types of patients. Because all people having the same disability are not alike—they have, for example, different occupations and psychological make-up, and varied medical problems—each device must be tested on a variety of people with the same disability. Findings of studies are compiled and used by manufacturers to provide the most suitable components for application to all patients.

Knowledge is provided to those responsible for the welfare of the patients. Both formal instruction and printed information are necessary to convey new information to those who are responsible for the treatment of the disabled. The medical schools of the University of California at Los Angeles, New York University, and Northwestern University offer short-term courses in prosthetics and orthotics for clinic teams and vocational-rehabilitation counselors. The funds necessary to operate the schools are provided by the Office of Vocational Rehabilitation, Department of Health, Education, and Welfare, by tuition fees, and by the universities themselves. The work of these three universities is supplemented by the Committee on Education of the American Orthotics and Prosthetics Association and by the Committee on Prosthetics Education and Information of the National Academy of Science—National Research Council.

With proper treatment and follow-up care, the disabled can regain much of their lost function and return to an independent, productive life.

1. 919 18th Street, N.W., Washington 6, D.C.

Slipped Upper Femoral Epiphyses. Dr. George B. Ambrose [2] and Dr. Harrison L. McLaughlin.

A Critical Review of a Series of Patients Following Myelography. Dr. David M. Bosworth [3], Dr. William J. Liebler, Dr. Wsewolod Herasymowcyz, and Dr. Raymond Pastor discussed a series of ninety-two patients who were seen months or years after myelography. The series represented patients who were still symptomatic, their problems sometimes related to myelography and sometimes to surgical or other procedures based on myelography. The series did not represent a consecutive group of patients on whom recent myelograms had been done.

The first intent of the study was to demonstrate how many of the symptomatic patients would have residuals of myelographic material within the cranial cavity. Many other facts appeared, such as distribution of the material within the dural sac; encystment of the dural sac; arachnitis; certain other neurological complications; and fallability of the test either in showing lesions or in showing lesions which later were proved non-existent.

As a portion of the exhibit, the authors included a panel that indicated the possibility of diagnosis of spinal lesions without myelography.

Myelography was of value, particularly where a tumor was suspected, to show its presence and extent. A myelogram could also prove valuable in showing the definite locale and nature of a lesion in questionable or difficult cases—those without gross findings after history, physical examination, and careful roentgenographic study. With a reduction in the use of myelography, reduction in adverse situations resulting therefrom should occur.

Bone Tumors Seen in Private Practice, 1937 to 1959. Dr. Louis W. Breck [4], Dr. Morton H. Leonard, Dr. Zigmund W. Kosicki, Dr. W. Compere Basom, Dr. Mario Palafox, and Dr. Adrian L. Grass.

Abnormal Hips in Abnormal Children. Dr. Thomas F. Broderick, Jr. [5], Dr. Kenneth A. Brown, and Dr. Richard D. Mulroy examined 1,000 children at the Kennedy Memorial Hospital in Brighton, Massachusetts, from September 1949 to November 1960. Of these children, 544 had cerebral palsy, seventy-one had poliomyelitis, thirty-one had meningomyelocele, and the others were mentally retarded. One hundred and twenty-one of the children examined had abnormal hips.

The authors reviewed the musculoskeletal problems of these children and are of the opinion that the most significant disability was related to dislocation of a hip. With the hip dislocated the problem of bracing, walking, and sitting is formidable and often insurmountable. When the hip was reduced, any other problem related to the lower extremity was easier to handle.

Roentgenograms were shown of the positions used for views of the pelvis, including supine and prone views with the hips in neutral, external, and internal rotation. The leap-frog view was valuable in determining anteversion, as well as whether the hip was dislocated anteriorly or posteriorly. A comparison roentgenogram was made with the Taylor-Martz view. There was a series of roentgenograms, made before and after operation, of patients with cerebral palsy and meningomyelocele showing the results after operations such as erector spinae transfer, the Pemberton procedure for rotation osteotomy of the pelvis, and the Mustard procedure for transfer of the iliopsoas muscle. The authors did seventeen erector spinae transfers and fifty-two adductor tenotomies and found them of great value in the more serious problems. The patients treated early could be handled by conservative methods.

In the normal child, unrestrained abnormal forces will result in subluxation or dislocation of the hip. In the abnormal child these abnormal dynamic forces are insidious, and the resulting deformity is catastrophic. In the abnormal child early orthopaedic evaluation is basic; prompt and vigorous intervention is imperative if the child is to stand or walk. The pediatrician and others entrusted with the care of the abnormal child should be educated to have the orthopaedic surgeon evaluate the patient regardless how gloomy the medical prognosis may be.

Spine Studies. Part II: Pelvic Obliquity. Dr. John R. Cobb [6], Dr. Konstantin Veliskakis, and Dr. Jürg Baumann.

2. 180 Fort Washington Avenue, New York 32, N.Y.
3. 742 Park Avenue, New York 21, N.Y.
4. 1220 North Stanton Street, El Paso, Texas.
5. 697 Cambridge Street, Brighton 35, Massachusetts.
6. 333 East 43rd Street, New York 17, N.Y.

Committee for the Advancement of Automobile Safety. Prevention of Automobile Injuries. DR. MURRAY E. GIBBENS [7], *Chairman*, and DR. ROBERT HANSON.

Committee on Bio-Mechanics and Implants. Tissue Reaction to Surgical Implants. DR. JACK WICKSTROM [8], *Chairman*.

Committee on Instructional Courses. Clinical Data—Cases for Instructional Course Dinner Program. DR. FRED C. REYNOLDS [9], *Chairman*.

Committee on Pathology. Diagnostic Problems of Joints. DR. CRAWFORD J. CAMPBELL [10], *Chairman*. The history, roentgenograms, microscopic pathology and, where pertinent, gross pathology, and a brief report of the diagnostic features of the following entities were described: sickle-cell anemia of the hip joint; aseptic necrosis of the carpal lunate; tuberculous arthritis and periarthritis of the shoulder; pyogenic arthritis of the hip; pigmented villonodular synovitis of the hip with secondary destruction of bone; osteoid osteoma of the distal femoral epiphysis with secondary synovitis of the knee; chondroblastoma of the femoral head; synovial sarcoma of the distal part of the femur and the knee joint; multiple osteocartilaginous loose bodies of the hip joint; gouty arthritis of the knee; rheumatoid arthritis of the elbow; and traumatic arthritis of the knee joint, secondary to a foreign body (glass) embedded in the femoral condyle.

Kissing or Contact Hip Syndrome. DR. JOHN W. COOPER [11] said that this world-wide occurring, often productive, and also, as often, an extensively destructive lesion on the anterior surface of the femoral neck, has escaped clinical recognition in North America until now. It has been known to anatomists and physical anthropologists for almost 100 years. They described and illustrated it extensively in the literature during this period, but apparently no note was made of the clinical and surgical correlation. Dr. Cooper's study offered evidence that this lesion, which alters the bone cortex in two special areas on the front of the femoral neck just below the head and in a constant area posteriorly, was present in the Neanderthal man of perhaps 230,000 years ago, in the Egyptians of about 4,000 years ago, and in skeletons from the English Midlands of the fifteenth, sixteenth, and seventeenth centuries. It was present in the Maori of New Zealand; in the Hawaiian of the pre-Captain Cook era (1778); in California Indians of from 1924 to 1934; and in 1960, in the skeletons of men from Iowa, Hawaii, New York, and Hong Kong. The incidence of the lesions in all the skeletons studied was from 66 to 72 per cent.

In 1959 the author recognized this kissing or contact hip lesion as a separate and distinctive entity in a man, fifty-one years old, and removed it for the first time. At surgery, the two-centimeter lesion was found to be reddened, granular, elevated, and erosive. Results were satisfactory. Subsequently, three cases were recognized and the patients relieved by surgery. The first known case to come to Dr. Cooper's attention was traced, and the patient was interviewed in 1960. This search revealed that he was operated on in New York in 1955 after all the usual conservative measures were tried. To date, complete relief of right hip pain has continued.

Because of failure to make a diagnosis, long periods of disability of from two, five, and nine years, respectively, existed prior to surgery in each of the author's three patients. Over the age of eighteen years the lesion on the anterior femoral neck is in 4 degrees of bone abnormality. As a pressure phenomenon it can appear:

1. As a surface erosion with possible roentgenographic findings;

2. As a productive bone excrescence, or exostosis, and erosive soft-tissue surface changes, easily identified in roentgenograms if a true lateral view of the neck next to the head of the femur is made. Both lesions (1 and 2) are to be found in the upper one-third of the anterior femoral-neck surface;

3. In the lower two-thirds of the anterior neck, a second pathological zone is found as a variable-depth linear groove or depression, one-quarter of an inch wide or wider, parallel to the anterior border of the head. This groove replaces the hardened cervical cortex exposing the cancellous bone and suggests a possible cause of fracture of the neck of the femur. This destructive and non-bone-productive lesion in some, and obviously marginal bone-productive lesion in others, is most readily seen in true lateral roentgenograms of the neck of the femur;

4. A combined lesion of the upper one-third and lower two-thirds does occur in many cases. Also, each hip may have a different lesion.

7. Veterans Administration Hospital, Denver 20, Colorado.
8. 4440 Magnolia, New Orleans 15, Louisiana.
9. 4960 Audubon Avenue, St. Louis 10, Missouri.
10. 721 Madison Avenue, Albany 8, New York.
11. 353 Young Hotel Building, Honolulu 13, Hawaii.

A similar lesion occurs on the posterior surface of the femoral neck in a smaller percentage of cases, either concomitantly or alone. It is easily seen in skeletal specimens, but its pathological significance today is unknown.

Furthermore, because a kissing lesion requires two parts, a concomitant, compression, soft-tissue or bone lesion frequently exists on the upper and anterior acetabular margin or in the labrum glenoidale, which is frequently severely damaged. These are also seen on roentgenograms in many chronic cases.

Because surface erosions and lesions with early periostitis are difficult to see on roentgenograms, or may show little change, one should be sure that roentgenographic study is ample. This lesion is to be considered probable and likely present when one is aware that, even with a normal-looking roentgenogram, two out of three times the lesion exists.

Clinically, the diagnosis is substantiated by production of pain in 90 degrees of hip adduction and internal rotation, the position which produces contact between the acetabular margin and the femoral neck. The pain phenomenon can be reproduced by this examination.

Dr. Cooper emphasized that the kissing or contact hip syndrome is a specific, chronic lesion and not a part of generalized osteo-arthritis; it is present frequently with positive roentgenographic signs; and that it is amenable to surgical treatment.

Prevention and Management of Traumatic Thumb-Web Contractures. Dr. Lee J. Cordrey [12] presented his methods of preventing thumb-web contractures following trauma to the hand and pointed out the correct and incorrect procedures in splinting and surgical immobilization. The surgical technique and principles of management of the severely contracted thumb web were shown in combination with illustrations of the anatomical structures involved. One illustrative case demonstrated the author's principles of management: (1) correcting the osseous deformity; (2) releasing the thumb web; (3) splinting with internal fixation; and (4) covering the skin defect.

New Concepts on Etiology and Treatment of Legg-Calvé-Perthes Syndrome. Dr. William A. Craig [13], Dr. Warren G. Kramer, Dr. Eduardo R. Luque, and Dr. Robert Watanabe believe that the etiology of Legg-Calvé-Perthes disease is repeated trauma to the anterior aspect of the femoral head as it strikes against the anterior margin of the acetabulum.

The initial lesion is found in the anterior aspect of the femoral head and consists of an area of pressure necrosis. With continued pressure and trauma, the fluid-filled cavity transmits the focal pressure hydraulically in all directions, causing extension of the pressure necrosis both through the epiphyseal plate into the metaphysis and across the entire epiphyseal plate. The former causes osteolytic pressure necrosis in the neck or so-called cysts of the neck. The latter, above the epiphyseal plate, causes the widened epiphyseal zone visible in the early stages of Legg-Calvé-Perthes disease.

Treatment, therefore, is directed toward the realignment of pressure on the femoral head. This may be done conservatively by maintaining a position of abduction and internal rotation of the lower extremities with a between-shoe splint. In certain indicated cases subtrochanteric osteotomy has been done to decrease anteversion and put the femoral neck in a position of less valgus. Other patients have had an iliac osteotomy after the method of Pemberton; this brings the anterior margin of the acetabulum forward and corrects the inadequate depth and cupping of the acetabulum.

In all three methods of treatment the softened portion of the femoral head is repositioned to prevent further trauma against the anterior margin of the acetabulum.

A Reliable Operative Procedure for Recurrent Dislocation of the Shoulder. Dr. Carlos DeAnquin [14].

Hallux Valgus and Metatarsus Primus Varus. Dr. Donald C. Durman [15] tabulated the roentgenographic findings of approximately 1,500 feet, some normal and some with hallux valgus, to show the possible relationship between the amount of metatarsus primus varus and the amount of hallux valgus. These tables were part of an exhibit which also showed roentgenograms of several representative cases of hallux valgus and metatarsus primus varus. Photographs shown included feet before and after operation; immediate postoperative dressings and convalescent splints; and special instruments. Charts displayed listed the indications for correction of metatarsus primus varus and the various steps of the operative procedure.

12. 4801 Woodmere, Tampa 9, Florida.
13. 117 East Hadley Street, Whittier, California.
14. Hospital Militar, Cordoba, Argentina.
15. 408 South Jefferson Avenue, Saginaw 16, Michigan.

The Pathogenesis of Synovial Cartilage. Dr. William F. Enneking [16] and Dr. Nicholas R. Greville based their discussion on the clinical, anatomical, and pathological studies of six cases of synovial osteochondromatosis. Histological evidence demonstrated the metaplastic change of the primitive mesenchymal cells in the deep layers of the joint capsule into chondroblasts and the subsequent formation of small islands of cartilage within the joint capsule. Extrusion of these cartilaginous islands within the joint was in a serial fashion with subsequent calcification and growth of these cartilaginous bodies within the joint. Reattachment of these cartilaginous loose bodies to the inner aspect of the joint capsule was shown with their subsequent invasion by capillaries and endochondral ossification. Subsequent osteoclastic resorption of these ossified bodies was demonstrated. These histological sequences were correlated with the anatomical findings at surgery; the subsequent clinical course was demonstrated by roentgenograms.

Macroradiography in Orthopaedics. Dr. Irving E. Fixel [17].

Salvage of the Rheumatoid Hand. Dr. Adrian E. Flatt [18] and Dr. Donald Kettelkamp emphasized the importance of early surgical consultation in patients with rheumatoid arthritis of the hands. Case records and plastic casts of patients' hands showed the rapidity with which this disease can cripple. Surgical procedures for the correction of the deformities involved (1) the soft tissues and (2) the joints.

Discussion of surgery involving the soft tissues centered largely around the proved value of prophylactic synovectomy of both the flexor and the extensor compartments. Tendon ruptures can be caused by both disease and attrition. The authors also discussed tendon substitutions and pointed out that the most satisfactory results were obtained by tendon transfer. They stressed the early use of intrinsic release and, to point out the results that can be obtained, showed preoperative and postoperative casts of a patient.

Finger-joint fusion and arthroplasty by a prosthesis were compared. Casts of patients' hands before and after placement of metallic prostheses were shown. Although this method is still experimental, it does appear to be of use in the replacement of diseased finger joints in certain cases.

Eosinophilic Granuloma of Bone. Dr. Kenneth C. Francis [19], Dr. Henry M. Selby, and Dr. John L. Sbarbaro, Jr.

Spine Tuberculosis Treated without Surgical Fusion. Dr. Barry Friedman [20].

Statewide Orthopaedic Studies. The Scientific Research Committee of the Pennsylvania Orthopaedic Society. Dr. John J. Gartland [21], *Chairman*, Dr. Albert B. Ferguson, Jr., Dr. William F. Donaldson, Jr., Dr. Marvin C. Goodman, Dr. Ervin E. Rodriguez, and Dr. Michael Skovron. This committee was set up in 1957 to study selected orthopaedic topics at a state level in an effort to organize into statistically significant data the combined experience of the orthopaedic surgeons of Pennsylvania. The study conducted in 1958 was entitled "Fresh Midshaft Fractures of the Humerus in Adults. Evaluation of Treatment in Pennsylvania during 1952–1956". This study was reported in *J. Pennsylvania Med.*, 62: 848–850, 1959.

In 1959 the Committee studied "Traumatic Dislocation of the Hip Joint in Children" and published the report in *The Journal of Bone and Joint Surgery*, 42-A: 705–710, June 1960.

The project for 1960 was "Evaluation of Surgical Treatment for Non-Union of the Navicular".

The exhibit concerned itself with the statistically significant data unearthed by the projects of 1958, 1959, and 1960.

Spine Instrumentation in the Management of Scoliosis. Dr. Paul R. Harrington [22] presented a concept of spine mechanics derived from experimental studies and clinical observation. He also exhibited the spine instruments used in the management of scoliosis and described his technique in applying them.

Graphs were shown of: (1) clinical evaluation up to the present time; (2) indications, contraindications, and criteria for use of the instruments in scoliosis; and (3) cardiorespiratory function correlated with scoliosis.

16. University of Florida College of Medicine, Gainesville, Florida.
17. 3705 Hollywood Boulevard, Hollywood, Florida.
18. State University of Iowa, Iowa City, Iowa.
19. Hospital for Special Surgery, New York 21, N.Y.
20. 2460 Fairmount Boulevard, Cleveland Heights 6, Ohio.
21. 269 South 19th Street, Philadelphia 3, Pennsylvania.
22. 1333 Moursund Avenue, Houston, Texas.

The Trapezius as a Cause of Persistent Symptoms in Whiplash Injury: A New Operation for Symptomatic Relief. Dr. William S. Hatt [23] described the trapezius spasm, with its resultant increase in the concomitant cervicobrachial reflexes, as a cause of persistent pain after projectile injuries to the neck.

Results in a limited series of cases were tabulated in Dr. Hatt's operation of trapezius-tendon lengthening.

A Medical Adventure in International Goodwill. Dr. Charles U. Hauser [24], Dr. Allan McKelvie, and Dr. Theodore Norley presented the reasons for and results of a recent medical mission conducted in Jordan by a group of twenty-five American orthopaedists. Acknowledgement was paid to MEDICO, UNRWA, and Jordanian officials for their encouragement and to the drug and instrument houses for their generous support. Photographs were shown of typical patients, and tables of the statistical and educational results were displayed. Participants in the project were on hand to explain the mission and to encourage others to support similar efforts in other areas of the world.

Surgical Treatment of the Hand in Rheumatoid Arthritis. Dr. Edward D. Henderson [25], Dr. Paul R. Lipscomb, Dr. Emmerson Ward, and Dr. R. H. Ferguson.

Diagnostic Clinic in Osteo-arthritis. Dr. David S. Howell [26], Dr. Harvey E. Brown, Jr., and Dr. Augusto Sarmiento described the pertinent clinical features, roentgenograms, and pathological findings of eight patients referred to an arthritis clinic with a diagnosis of osteo-arthritis.

The means for arriving at a proper diagnosis and appropriate management were outlined. In addition to osteo-arthritis, the cases presented included acromegaly, gout, ochronosis, rheumatoid arthritis, and lumbar-disc protrusion.

Bone Changes in Sickle-Cell Disease. Dr. Loyal W. Jodar [27], Dr. Frederick J. Fischer, and Dr. Richard Lamont illustrated, with roentgenograms, the classic changes described in the literature as being attributed to sickle-cell disease. These included changes due to marrow hyperplasia with widened intramedullary canals, narrow cortices, thickened trabeculae, and osteoporosis. Also illustrated were changes due to the fragility of the sickle-shaped cells: degenerative changes such as bone sclerosis, narrow intramedullary canals, wide cortices, aseptic necrosis, and periosteal elevation. A series of roentgenograms were compared with those of twelve different pathological entities; in each case the roentgenograms were quite similar, pointing out that discernment is needed to make the correct differential diagnosis.

Differential Diagnosis of Isolated Bone Lesions Containing Giant Cells. Dr. James I. Kendrick [28], Dr. George S. Phalen, and Dr. L. J. McCormack exhibited transparencies of roentgenograms and Kodachrome reproductions of pathological specimens of metabolic disorders, tumors, tissue rests, and defects in bone. Many isolated bone lesions contain giant cells, and consultations with the roentgenologist, pathologist, and clinician are necessary to identify the exact nature of the bone lesion and to decide the treatment indicated.

Locomotor Patterns in Children with Cerebral Palsy: Electromyographic Comparison with Normals. Dr. William E. Kenney [29] and Paul C. Heaberlin, Jr., R.P.T., made electromyographic tracings of children with cerebral palsy and of normal children carrying out certain actions. Composites were used to show diagrammatically the patterns obtained on the electromyogram. Both the normal children and the children with cerebral palsy were studied by eight channels simultaneously, four from the anterior locations (anterior neck, upper and lower parts of the abdomen, and anterior thigh) and four from posterior locations (posterior neck, lower thoracic, lower part of the back, and posterior thigh). The motions studied were sitting-up, straight leg-raising, bilateral straight leg-raising, and the same actions done against resistance. It was found that the normal locomotor pattern spreads in an orderly and sequential fashion. For example, in sitting-up, the normal subject uses first his anterior neck, then his abdominal muscles, and last his

23. 1852 Hillview Street, Sarasota, Florida.
24. 128 North Front Street, Hamilton, Ohio.
25. 200 First Street, S.W., Rochester, Minnesota.
26. University of Miami School of Medicine, Miami, Florida.
27. 19515 Mack Avenue, Grosse Pointe 36, Michigan.
28. 2020 East 93rd Street, Cleveland 6, Ohio.
29. 218 Calvin Street, Fall River, Massachusetts.

anterior thigh. The posterior muscles are called into play late in the act and appear assistive in power. In children with cerebral palsy on attempts at sitting-up, a massive and almost immediate response from all the anterior muscles was seen. That is, the anterior neck, upper and lower parts of the abdomen, and anterior thigh muscles become active within 0.2 second of the onset of the act, as compared with 1.5 seconds in the normal child. Furthermore, the posterior muscles respond with considerable power within 0.2 second of their analogous anterior muscles. The posterior muscles therefore appear to obstruct or prevent an act rather than to aid the act, as in the normal subjects. This sudden powerful obstructive response of the antagonists in children with cerebral palsy is probably in the nature of a stretch reflex.

The Role of Drug Administration in Orthopaedics. Dr. Otto C. Kestler [30].

Entrapment Neuropathies—Upper and Lower Extremities. Dr. Harvey P. Kopell [31], Dr. J. Giattini, and Dr. Walter A.L. Thompson said that an entrapment phenomenon occurs at a point where the anatomical configuration may cause constriction of a peripheral nerve. For any movement of an extremity, a nerve must be permitted a passive range of motion with relation to other structures in the extremity. The entrapment region, either an osseofibrous tunnel or fibrous-edged slit, is unyielding and inelastic. There is little cross-sectional latitude for dimensional alteration of the contents of the passageway. This represents a point of vulnerability for mechanical trauma to the nerve. Once traumatized, the anatomical disposition of structures is such as to maintain a state of inflammation.

Entrapment points are the suprascapular, radial, ulnar, median, obturator, sciatic, saphenous, peroneal, and interdigital nerves.

The diagnosis of entrapment neuropathy is not only important for itself; it must also be differentiated from a syndrome based on a radiculopathy.

The Hoover Sign: An Objective Sign of Pain or Weakness, or Both, in the Back or Lower Extremities. Dr. William A. Larmon [32], Dr. Alex J. Arieff, Dr. James F. Kurtz, and Dr. Eli L. Tigay rec lled that in 1908 Dr. C.F. Hoover of Cleveland, an internist interested in physical diagnosis, described "a new sign for the detection of malingering and functional paresis of the lower extremities". Most clinicians remember this sign as only of value in ruling out organic weakness; however, this sign is also a positive one in mild hemiparesis and invaluable in the detection of patients with pain or weakness, or both, such as in sciatica or lumbosacral radiculitis, or both. This sign is based essentially on the fact that, if a normal person in the supine position is asked to lift one extended lower extremity, the opposite heel will be observed to press against the resisting surface or the palm of the examiner's hand. If pain, or weakness, or both are present in the lower part of the back or lower extremity, when the painful extremity is elevated, the opposite, or normal, extremity will press into the resting surface, or the palm of the examiner's hand, more than when the opposite maneuver is performed. This fact was demonstrated in the exhibit and illustrated by electromyographic studies and a demonstration of the performance of the test with appropriate readings on a spring-balance scale to make the sign objective.

Sea Shell Splint. Dr. Philip O. Lichtblau [33] described a simple device for use as an opponens or first-web spacer. It is simply constructed with a sea shell of appropriate size, two small metal bands attached by single screws, and a hand strap. It is amazingly light-weight, durable, attractive, and functional. The simplicity of construction and availability of material make it an ideal project for occupational-therapy departments, where it can be constructed in a matter of moments at a cost of just pennies. For children particularly, for whom novelty is most useful, it is ideally suited to therapy after poliomyelitis, traumatic nerve lesions, and burn-scar contractures.

Hip Fractures: Treatment Based on Biomechanical Principles Utilizing a Sliding Nail Technique. Dr. William K. Massie [34], Dr. Kenneth Phillips, and Dr. David B. Stevens said the objective of their report was: (1) to re-emphasize the principles underlying adequate reduction, adequate apposition, and adequate immobilization of the fragments of both intracapsular and extracapsular fractures; and (2) to compare statistically the results of three groups of cases treated and evaluated by one surgeon, showing a parallel comparative reduction in non-union,

30. 140 East 54th Street, New York 22, N.Y.
31. 415 East 52nd Street, New York 22, N.Y.
32. 700 North Michigan Avenue, Chicago 11, Illinois.
33. 5312 Broadway, West Palm Beach, Florida.
34. 304 South Limestone, Lexington, Kentucky.

delayed union, and avascular necrosis of intracapsular fractures. In the first group, a rigid nail or a rigid nailplate was used. In the second group, a sliding nail was inserted at 155 degrees, but not utilizing optimum impaction at surgery. In the third group, the more recent sliding-nail appliance designed by one of the authors was employed, utilizing optimum impaction at surgery. Evidence was presented to support the concept that each non-union in all the series was the result of a technical failure either at surgery or during the postoperative period. It was emphasized that many techniques lead to adequate treatment of this fracture, but that the criterion of adequate treatment is a variable, related to and dependent upon the degree of protection provided the hip in its healing stage. The less the postoperative protection, the more the stability required, and vice versa. Impaction of the fragments at surgery so that the fragments are actually invaginated one into the other is calculated to provide maximum stability. A comparative evaluation of impaction by the bolt or screw method was shown to be inferior to the stroke method, using a sliding nail. The comparative stress was evaluated by strain gauges on an oscillograph. The rate of avascular necrosis was related to the rate of healing; it was present in 100 per cent of non-unions; in 60 per cent of delayed unions (healing incomplete at six months); and in 10 per cent of seventy-three displaced hips proceeding to union at a normal rate. It was concluded that 10 per cent of the cases of avascular necrosis in this series appeared unrelated to treatment.

Forty-eight extracapsular fractures treated with a sliding nail and impaction were compared with twenty-seven similar fractures treated with rigid-nail fixation. Impaction in this group is feasible at surgery and produces a stability that justifies immediate weight-bearing. One type of extracapsular fracture with the fracture line parallel to the plane at insertion of the nail was not amenable to the use of the sliding-nail appliance. Impaction with early weight-bearing in this group was not accompanied by any complication and was of considerable economic importance.

Technically, a single nail of adjustable length with two lengths of plates is applicable to all types of fractures around the hip with the exception of the one type just mentioned, which was present in 6 per cent of the extracapsular fractures.

An Evaluation of Extremity Loss Due to Venomous Snake Bite in the State of Florida. Dr. Newton C. McCollough[35], Dr. Donald W. Grimes, Mr. Ross Allen, and Dr. Joseph F. Gennaro, Jr., showed colored transparencies depicting the venomous snakes indigenous to Florida that were responsible for the injuries described. Of fifty-three cases collected from physicians in active practice in Florida, thirty-six led to amputation and seventeen to soft-tissue slough in a major extremity. There were also transparencies showing the severity of the injury in three or four cases. One, in particular, showed seven views of a hand in which the bite occurred in the web of the thumb and led to mid-forearm amputation. It was the authors' opinion, after study of the literature on experiments in which snake bites were treated with various methods and after review of the clinical analyses of the fifty-three cases, that immobilization immediately after the bite is of prime importance and that incision and suction is of considerable value if applied immediately and through small incisions over the fang marks over a period of not more than one hour. A lightly constrictive tourniquet occluding superficial veins and lymphatics is of probable value during the period of incision and suction. The use of antivenin is the keystone in the treatment of venomous snake bites in Florida. A polyvalent antivenin produced commercially is adequate in neutralizing or precipitating the venom of the major offenders, the pit vipers—the eastern diamondback rattlesnake, the cottonmouth moccasin, the pigmy or ground rattlesnake, and the upland moccasin or copperhead.

The cases in the group studied suggest, from a review of the record, that antivenin was used locally too often, increasing local tissue tensions in an area of poor absorption, and intramuscularly too often where absorption is slow owing to shock and poor peripheral circulation. Antivenin should be used intravenously and in large amounts, a minimum of five to six ampules, where the symptoms of the bite would suggest that it is grave. In a grave bite these symptoms appear within thirty minutes; they include immediate progressive swelling, pain at the site of the bite, and constitutional symptoms consisting of fasciculation, ataxia or incomplete paralysis, hematemesis, melena, and hematuria.

Cryotherapy is contra-indicated on two sound bases: (1) the experimental literature; and (2) the clinical analyses of this group of cases. In twenty-three of the twenty-seven cases which resulted in amputation, the patients reported the use of cryotherapy in excess of twelve hours. In most of these cases, the method was immersion in ice water; in others, it was packing the extremity in ice bags.

There is no question that many venomous snake bites result in the injection of very little venom. This variability makes it almost impossible to come to any conclusion regarding therapeutic

35. 1141 Delaney Street, Orlando, Florida.

results in the treatment of this injury in human beings. The authors feel that there should be a better correlation between the evidence collected in the experimental literature on the treatment of snake bites and that outlined for clinical use. Even at this time there are disputes occurring in the medical literature concerning the treatment of this injury in human beings; none of this conflict has been settled on the basis of the laboratory research reported, but rather on the feeling or suspicion of the author that such and such a method is or is not of value. The average hospital emergency room and school libraries should be supplied with posters with colored photographs of the snakes of the region, for purposes of identification, and a brief résumé of treatment for snake bite.

Management of Severe Supracondylar Fractures of the Humerus. Capt. William J. Mitchell [36] and Dr. John P. Adams reported on a ten-year follow-up study of the results of treatment of eighty-three supracondylar fractures of the humerus in children under fifteen years of age.

This study directed the authors' attention to Dunlop's type of skin traction as the most effective form of management for severe supracondylar fractures of the humerus—those in which there is complete displacement of the distal fragment.

Compared with other methods of treatment used during the same ten-year period (closed reduction and plaster immobilization; posterior plaster-slab immobilization), Dunlop traction was associated with a decreased incidence of cubitus varus (gunstock deformity), absence of circulatory deficit, and maintenance of position as initial edema subsided.

The low incidence of cubitus varus is attributed to the effects of continuous traction in preventing medial tilt of the distal fragment.

Three patients treated initially with closed manipulation and plaster cast manifested signs of impending vascular deficit. The immediate application of Dunlop traction reversed the signs of threatening circulatory embarrassment.

Eight patients treated with closed reduction and plaster immobilization lost position on two or more occasions while in the cast, but responded satisfactorily and maintained position when Dunlop traction was applied.

Final analysis of the results of this ten-year follow-up study of eighty-three patients emphasized the following: In the treatment of severe supracondylar fractures of the humerus in children, Dunlop traction is far superior to closed reduction and plaster immobilization because: (1) there is less cubitus varus; (2) there is a lessened possibility of subsequent loss of position; (3) the danger of impending circulatory embarrassment is greatly decreased; (4) complications such as infection and stiffness that have been associated with skeletal traction and open reduction are not encountered; and (5) general anesthesia is unnecessary.

Acetabular Stress from Femoral-Head Prostheses. Dr. E. James Morrissey [37], Dr. Charles F. Snyder, Jr., and Dr. Lowell C. Yund exhibited models of three acetabula with a movable Austin Moore prosthesis fitting into each.

In one model the diameter of the acetabulum was forty-six millimeters (one and four-fifths inches); the diameter of the Austin Moore prosthesis was one and three-quarters inches, showing incongruity in the point of contact in a small area. In the second model, the diameter of the acetabulum was forty-six millimeters (one and four-fifths inches) and the diameter of the prosthesis was also forty-six millimeters (one and four-fifths inches). In the third model, the diameter of the acetabulum was forty-six millimeters (one and four-fifths inches); the diameter of the Austin Moore prosthesis was one and seven-eighths inches, showing contact only at the edges of the acetabulum.

The authors pointed out that:

1. The maximum acceptable difference in prosthesis-acetabular diameter is one-thirty-second of an inch. A difference of one-sixteenth of an inch increases the pressure four times; a difference of one-eighth of an inch increases the pressure nine times.

2. Prostheses are currently available only in increments of one-eighth of an inch, forcing the use of unacceptable sizes in 50 per cent of acetabula.

3. Sound mechanical principles indicate the use of more closely matched sizes—a minimum of one-sixteenth-of-an-inch increments should be available.

Prostheses with increments of one millimeter (one-thirty-second of an inch) were advocated to obviate the necessity for using slightly oversize heads and to stay well within the range of acceptability.

Recurrent Dislocation of the Shoulder. An Orthopaedic Monograph with Viewmaster

36. Westover Air Force Base, Massachusetts.
37. 1121 Penn Avenue, Wyomissing, Pennsylvania.

Stereophotography of the Surgical Anatomy and Basic Lesions. H. FREDERICK MOSELEY, D.M.,[38] and HELEN T. MACARTHUR.

Help and Hope for the Dystrophic Patient. DR. ADE T. MILHORAT[39], *Director,* Muscular Dystrophy Associations of America, Inc., presented a technical exhibit suitable for national, regional, and state scientific meetings.

One panel consisted of a series of figure drawings with accompanying text of the manifestations of muscular dystrophy and a statistical breakdown by age group of the incidence of this disease. Another panel showed the areas of research in quest of the cause and cure for muscular dystrophy. Line drawings with explanatory text of various animals in which muscular dystrophy occurs gave visual illustration to the concept that muscular dystrophy is not confined to man but appears in many species of animals.

Evaluation of a New Drug Effective in Cerebral Palsy. DR. WINTHROP M. PHELPS[40] keeps continuous graphs of improvement in the use of the legs, arms, and speech on all patients at the Children's Rehabilitation Institute, showing their progress without treatment, with treatment, and with the addition of various drugs, given either intermittently or continuously. The graphs also show the effects of withdrawal of medication, soma, as an example. The graphs also show the different types of cerebral palsy and the response to the drug evaluated.

Dr. Phelps believes that this is a good alternative method of evaluation to the double blind test when patients are completely controlled in a residential center.

Internal Fixation of Bone Fragments with Flexible Wire and Pins. DR. F. W. RHINELANDER[41] and DR. M. A. BRAHMS demonstrated refined techniques for internal fixation of bone fragments with flexible steel wire and small-diameter steel pins, and illustrated, by roentgenograms of a large variety of cases, the excellent results obtained by proper application of the method. Results of experiments, employing microangiography to delineate the blood supply of healing bone, were also shown.

Microangiograms demonstrated reconstitution of medullary and periosteal blood supply in the dog's ulna after osteotomy and fixation by wire. Application of a circumferential wire loop subperiosteally to the dog's femur did not interfere with access to the cortex of new blood vessels from the periosteum, while application of a Parham band blocked access of periosteal vessels to the wide zone of cortex beneath it. After six months, blood vessels derived from the medullary circulation had penetrated the cortex outward to the undersurface of the Parham band. New bone had grown completely over the wire loop by seven weeks, but did not envelop the band at any time up to six months. Thus, wire loops and Parham bands lead to very different developments in the tissues. Clinically also, as demonstrated in cases presented, new bone grows over wire loops with great facility if the adjacent tissues are not devascularized. Furthermore, both experimentally and clinically, wire loops do not cause erosion of bone, any more than screws do, if the bones themselves are securely fixed so that motion does not take place.

The value of special tools, and of ancillary fixation devices for use with wire, was emphasized—with the aid of prepared bone specimens. The basic instrument is a spring-loaded wire twister which permits the securing of wire loops at a constant and reproducible tension, so that wires are not broken or strained. Wire passers, bent by the surgeon to the contours of the bone, allow wire loops to be passed closely outside the periosteum—sparing more periosteal stripping, and consequent devitalization of bone, than has already been caused by the fracture. A simple bone-holding clamp effects temporary fixation of bone fragments by tightening a wire loop around them, thereby avoiding the insertion of large clamps into the wound. A C-clamp with drill guide aids reduction and fixation of fractures in major joints. A wire-washer set, which acts like a bolt with washers and nuts, effects permanent internal fixation. A sliding bone plate, shaped like an angle iron, with one flange seated in a longitudinal saw cut, is maintained in position by wire loops. It controls rotation of transverse shaft fractures, without holding bone fragments apart, and is often used in conjunction with a medullary rod. A key type of bone graft, secured by wires passed through drill holes, is effective for treatment of non-union due to rotation about intramedullary rods.

For repeated success, as has been obtained with the methods described, surgical facility and attention to detail are necessary. Essential points of technique were summarized as follows: (1) sufficient number of wires; (2) wires properly placed; (3) wire sufficiently strong (18-gauge for femur

38. McGill University Press, Montreal, Quebec, Canada.
39. 515 East 71st Street, New York 21, N.Y.
40. 3038 St. Paul Street, Baltimore 18, Maryland.
41. 3395 Scranton Road, Cleveland 9, Ohio.

and tibia and 20-gauge for humerus, radius, ulna, and fibula); (4) wire not overstrained on tightening; (5) small pins—ancillary to wire or independently (for fixation of small bone fragments near joints, or where minimal internal fixation is desired, such as with open fractures); and (6) no periosteal stripping.

Closed reduction of fractures is the ideal method of treatment; where open reduction is indicated, the technique employed should produce in the tissues as little deviation as possible from the conditions which would obtain after closed reduction. In this regard, the method of internal fixation which depends primarily on flexible wire and pins, often supplemented by plaster, has the following attributes: it provides secure fixation when properly applied; it maintains bone ends in constant contact and does not hold them apart; and it requires a minimum of surgical exposure with a minimum of implantation of foreign material, and, therefore, produces minimum devitalization of bone. The likelihood of complications, and their severity if they occur, are thereby minimized. Thus, the conditions attendant upon closed reduction are more closely approached than with other surgical methods.

A Rehabilitation Center Serves a Community. Dr. Dean W. Roberts [42] and Jayne Shover described a rehabilitation center for crippled children and adults, in Dade County, Florida. The center houses five services—administrative, medical, psychological, social, and vocational. The personnel participating in the rehabilitation program are: physician, physical therapist, orthotist, speech therapist, psychological tester, social worker, pre-vocational tester, and vocational counselor.

Right-Sided and Left-Sided Prostheses with Interchangeable Lock-on Heads. Dr. Robert M. Rose [43] designed a prosthesis for right-sided or left-sided insertion into the hip of the human body. The advantages of the design were pointed out by a comparison with standard prostheses.

Since closeness of fit of both the head in the acetabulum and the stem in the marrow canal of the femur is essential for maximum success of a hip prosthesis, Dr. Rose's prosthesis is made in two stem sizes, for both the right and left sides. To obtain the closest correlation between head and stem fittings, the heads are interchangeable; to afford maximum security, the head can be rigidly and permanently locked onto the stem of the prosthesis.

The comparative femoral weight-bearing areas of standard prostheses and the author's prosthesis were also shown, as well as the approximation of the stems of standard prostheses to the marrow canal of the femur. The special prosthesis approximates the shape of the upper end of the marrow canal for closest fit and greatest support and is not diamond-shaped or rectangular in cross-section.

Shoulder Arthrography. Dr. Robert L. Samilson [44] and Dr. Frank L. Raney, Jr., performed contrast arthrography of the joint, utilizing anterior intracapsular injection of water-soluble radiopaque dye solutions, on more than 125 patients. They described fully the arthrographic findings obtained by this method in thirty patients and said the method is safe, easy, and can be done on an out-patient basis.

Consistent pathological patterns were obtained in the following conditions: seventy rotator-cuff tears; five tears of the long head of the biceps; eight tears of the transverse bicipital ligament of the biceps synovial reflection; nine anterior shoulder dislocations; three posterior shoulder dislocations; and seven frozen shoulders.

Cervical Brace. Dr. Ivan M. Spear [45] demonstrated a cervical brace in which the salient features were: (1) support of the head by a large chin cup and cups over the occipital protuberances and (2) a shoulder yoke. The mid-line of the brace is open posteriorly, avoiding pressure over the spinous processes. Ready access to dressings in the posterior cervical area is thus permitted with rigid immobilization and a maximum degree of comfort.

Internal Fixation of Difficult Colles' Fracture by Kirschner Wires. Dr. Kenath H. Sponsel [46] presented a new method of fixation of unstable Colles' fracture and described the details of introduction of wires into the distal fragment and across the fracture line to the proximal fragment. The preferred technique includes one longitudinal wire introduced dorsally into the distal

42. 2023 West Ogden Avenue, Chicago 12, Illinois.
43. 1520 Louisiana Avenue, New Orleans 15, Louisiana.
44. 3580 California Street, San Francisco 18, California.
45. 121 Lincoln Street, Worcester 5, Massachusetts.
46. 605 Tenth Avenue South, Minneapolis 4, Minnesota.

fragment and extending three or four inches longitudinally in the intramedullary portion of the proximal radius. The second wire is directed obliquely across the axis of the radius from the radial styloid into the radial cortex at the ulnar side of the proximal fragment. Kirschner wires, .062 inch in diameter, are cut below the level of the skin after insertion. A short arm cast is worn for six weeks, at which time removal of the two Kirschner wires is done under local anesthesia.

Examples of results were shown by roentgenograms and by photographs of range of motion. The longest follow-up was seven years. Dr. Sponsel used the method described fifteen times in a series of 175 Colles' fractures. No complications could be attributed to internal fixation by Kirschner wires; in fact, median neuritis, prolonged swelling, and pain were decreased by this method inasmuch as no awkward positions were necessary in the short arm casts. The author believes, after viewing 175 Colles' fractures, that this method could have been used with advantage two or three times as often.

Advancement of Profundus Tendon in the Fingers for Laceration of the Profundus and Sublimis Tendons. Dr. Kenath A. Sponsel [46] described a method of surgical repair of tendons lacerated in areas distal to the proximal interphalangeal joint. By partial or complete excision of the distal stump of the profundus tendon, advancement of the proximal profundus up to three-fourths of an inch is possible, placing healthy tendon at the site of laceration. When the profundus is cut in the middle phalanx, it usually can be repaired by advance of the proximal end to the bone at the distal phalanx. If the surgeon believes that advance to the tip of the finger will overly flex the distal phalanx, he may advance the profundus to the level of the middle or distal portion of the middle phalanx. At this level, an end-to-end anastomosis may be made with the remaining distal stump of the profundus after partial resection. Sometimes, a partial laceration of the sublimis tendon can be sutured and the profundus tendon advanced distally, with a final result of independent motion of the two tendons. More extensive injury to the sublimis necessitates resection of the sublimis and advance of the profundus.

Anatomical drawings and photographs at surgery and injury, in addition to follow-up photographs, demonstrated the technique of primary repair. In late cases, the profundus may be successfully advanced. By the technique described, primary repair of tendons in the distal two-thirds of the finger is feasible, even in the presence of minor elements of crush.

Interesting Orthopaedic Pathology—Can You Make the Diagnosis? Dr. Philip L. Staub [47] presented an exhibit of eight cases of interesting bone lesions. Each case included the history, original roentgenograms, and a Kodachrome photomicrograph of the biopsy specimen. The diagnosis, together with a brief follow-up of each case, was listed at the bottom of the panel beneath a hinged door which could be raised to permit the viewer to test his own diagnostic ability.

Split Diamond Nail for Tibia, Humerus and Femur. Dr. Dana M. Street [48] and Dr. David G. Vesely.

Rotational Deformities of the Lower Extremities and Their Clinical Significance. Dr. Alfred B. Swanson [49] and Dr. Perry W. Greene emphasized the fact that rotational deformities of the lower extremities do not necessarily correct spontaneously. It was therefore concluded that all objectionable deformities should be treated early in life. It was further felt that rotational deformities of the hips often predispose to secondary deformities, such as knock-knee in the external tendency and bow-leg in the internal rotation tendency. The deformities in the lower extremity should be carefully evaluated because the deformity may occur in different segments, may be present in the femur or in the tibia, and may be in the same or in opposite directions.

It was found in a study of 100 young adults that there is a significant number who have residual rotational and angular deformities which are objectionable from the symmetrical viewpoint and which may contribute to symptoms in ligamentous and joint structures later in life.

The Denis Browne bar is not a benign method of treatment and may cause secondary angular deformities if not properly used. An adjustable antirotation brace was presented to allow selective control of rotation at different levels. A simple cable rotation brace was also described. Photographs and models were used to show: (1) a simply constructed frame used in making anteversion roentgenograms; (2) a rotational goniometer to measure clinical femoral rotation of the hip; and (3) various postures which produce rotational deformities in the infant and young child.

47. 881 Lafayette Street, Bridgeport 4, Connecticut.
48. University of Arkansas Medical Center, Little Rock, Arkansas.
49. 313 Blodgett Medical Building, Grand Rapids 6, Michigan.

Intramedullary Cup-Stem Arthroplasty of the Hip. Dr. Charles O. Townley [50] and Dr. Sidney C. Walker described the principles and techniques of surgery when performing cup-stem arthroplasty of the hip. Prepared specimens of the femur, as well as photographs, diagrams, and an automatic slide projector, were utilized to demonstrate the surgical technique. The studies were based on experience gained from 173 arthroplasties done during the last nine years.

The importance of the preservation of bone by fitting the prosthesis to the existing condition, rather than excising bone to fit a given prosthesis to all conditions, was emphasized. The mechanical advantages of a concentric cup arthroplasty are combined with those of a stabilizing intramedullary stem. Attempt is made to bring the metal-femoral bone junction up into the confines of the acetabulum. It was pointed out that as long as this can be achieved the procedure is an arthroplasty and not a replacement.

A cup-stem prosthesis was also presented as the Number IV type of prosthetic device, which utilized stability from a superior semi-cup as well as the usual calcar-bearing flange. Because of the distribution of weight-bearing and added stability, it was felt that this prosthesis had advantages over current and commonly used prostheses.

Prophylaxis and Treatment of Pyarthrosis: A New Approach. Dr. Ben T. Bell [51], Dr. Peter Viek, and Dr. Samuel C. Santangelo said the likelihood of infection of joints through surgical invasion is only slightly less now than it was before the advent of antibiotics. Compound joint injuries and hematogenous pyarthrosis are also on the rise. Previous clinical studies have demonstrated that our present, commonly used antibiotics—while they establish adequate serum levels for combating the usual pathogens—do not cross the synovial barrier, and cannot, therefore, prevent or reduce intra-articular damage due to sepsis.

A clinical experiment was devised in conjunction with treatment of sixty patients suffering from effusive joint disorders affecting the knee. Diagnoses were established by routine procedures and synovial analyses. The sixty patients studied were divided into Ropes and Bauer Groups I and II. Aspiration of the effused joints was then carried out one hour after the administration of penicillin V or phenethicillin, both oral antibiotics of low molecular weight. A simultaneous blood-serum specimen was also obtained. Results showed that: (1) both agents orally administered give high penicillin serum levels for the prevention and treatment of blood-borne infection; (2) both agents give high penicillin levels (although lower than serum) in the synovial cavity of common diseased joints; (3) not only inflammatory, but also joints with normal synovial-fluid findings will concentrate both agents studied; (4) the high serum and synovial-fluid levels produced by phenethicillin are not increased by the concomitant use of probenecid; (5) a comparison of mean concentrations in synovial fluid with requirements given in an accompanying spectrum suggests adequate bactericidal action in the synovial fluid by both agents; and (6) absorption into the blood serum and diffusion into the synovial cavity is consistently higher and more reliable with phenethicillin than with penicillin V.

Recommendations were made on general treatment and prophylaxis of pyarthrosis, as suggested by findings in this study.

Dysgenesis of the Proximal Femur and Its Surgical Management. Dr. Philip D. Wilson, Jr.,[52] and Dr. Harlan C. Amstutz.

Vulcanizing Rotary Rasp as Acetabular Reamer. Dr. Ben R. Wiltberger [53] said the reamer he employs is an inexpensive tool used in tire vulcanizing. It is of highly tempered steel, has cuplike rasp teeth that do not clog, and cuts so efficiently that it can be used as a hand tool.

Pneumatic Tourniquet. Dr. Ben R. Wiltberger [53] uses a tourniquet made of a bicycle inner tube; a flat, one-eighth-of-an-inch-thick piece of polyethylene (for rigidity); a twill cover; and velcro strapping. A corsetier can assemble these and probably has on hand the velcro (nylon zipper). The one-to-fifteen-pound gas gauge, rubber tubing, and gas-pipe fittings are available at a plumbing supply house.

Surgical Fixation of Small but Important Bone Fragments with the Hookplate. Lt. Col. Wilhelm A. Zuelzer [54] illustrated, with roentgenograms and drawings, his experience with the use of the hookplate, stressing the need for surgically acceptable metal which is still malleable

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51. Bryn Mawr Medical Building, Bryn Mawr, Pennsylvania.
52. 535 East 70th Street, New York 21, N.Y.
53. 50 West Gay Street, Columbus 15, Ohio.
54. DeWitt Army Hospital, Fort Belvoir, Virginia.

and can be bent to conform to the contours of the bone. In contrast to other conventional methods for fixation of small bone fragments, screw fixation does not parallel, but lies at an angle of 90 degrees toward the main axis of possible renewed displacement, giving consistently reliable fixation. Futhermore, the screw lies in cortical bone (unicortical or bicortical) of the shaft and avoids the spongiosa which cannot give the desired, secure fixation. The hookplate should not be used as an instrument for forceful reduction; its only purpose is to maintain the reduction. The hookplate also has been used as a large washer in combination with a tibial bolt, as, for instance, in fractures of the lateral malleolus with widening of the ankle mortise. This simple method has given consistently excellent results in these otherwise difficult cases. The hookplate is well tolerated by the tissue, including the thin overlying skin, and is not routinely removed.

The following represents the author's experience with the hookplate:

Absolute Indication (it is felt that other methods give no equal, secure fixation):

1. Comminuted fractures of the medial malleolus;
2. Comminuted fractures of the olecranon;
3. Osteoporotic fragments; and
4. Non-union of the medial malleolus.

Relative Indication (cases in which the use of the hookplate has proved to be of real value):

1. Fracture of the medial malleolus;
2. Comminuted fractures of the olecranon;
3. Ankle fracture with widening of the mortise;
4. Fracture of the lateral malleolus; and
5. Simple fracture of the olecranon.

Occasional Indication:

1. Fracture of the trochanter major;
2. Avulsion fracture of the major tubercle of the humerus;
3. Fracture of the lateral condyle of the tibia; and
4. Comminuted fracture of the distal end of the tibia.

ORTHOPAEDIC RESEARCH SOCIETY

The Seventh Annual Meeting of the Orthopaedic Research Society was held in Miami Beach, Florida, on January 7 and 8, 1961. Résumés of the papers read follow:

Microangiography in Fracture Healing. Dr. Frederic W. Rhinelander [1] and Dr. R. A. Baragry studied fracture healing, using tissue-slice microradiographs and conventional histological preparations. Undisplaced fractures were produced in the forelimbs of adult dogs and the progress of healing was followed by serial roentgenograms. At the time of sacrifice, the limbs were perfused with barium sulphate and the specimens were decalcified. Microradiographs and histological preparations showed newly formed small vessels entering the cortex at the fracture site from both the medullary cavity and the periosteum after one week. The vascular patterns and the vascular invasion at different time intervals after fracture were described.

An Experimental Study of Joint Stiffness. Dr. Wayne H. Akeson [2] reported his studies of the changes in water content and in the chemical composition of the joint capsule and other articular soft tissues after immobilization. One knee joint of each of fifty dogs was immobilized by internal fixation. The animals were sacrificed after periods of immobilization ranging from one to twelve weeks. Capsule, tendon, synovial lining, and other articular tissues from the immobilized joints and from the opposite knee, which served as a control, were analyzed for water, hexosamine, and hydroxyproline. After a transitory rise of 2 per cent in the water content in tendon during the first four weeks, the water content decreased throughout the remainder of the experiment. The content of hexosamine showed a similar rise of about 10 per cent, followed by a fall after four weeks. The hydroxyproline did not change. In contrast to tendon, the capsule and synovial lining showed a steady decline of water content and hexosamine with no change in hydroxyproline during immobilization. The possible significance of these changes was discussed.

The Role of the Parosteal Tissue in the Post-traumatic Osteogenesis of Long Bones. Dr. Leo Jarry [3] and Dr. Hans K. Uthoff studied the role of the parosteal tissues in the healing of tibial fractures in rats. The fractures were isolated from the surrounding tissues by polyethylene tubing which was laid around the fractured bone to include the periosteum. The fractures so enclosed showed little callus formation, and delayed union or non-union developed with or without intramedullary fixation. When windows were cut in the polyethylene tube, and the fractures were immobilized with intramedullary fixation, union occurred. The authors concluded that for fracture healing, the parosteal tissues must have easy access to the fracture site and that these tissues are not specifically osteogenic. They suggested that when exposed to inductor substances the parosteal tissues may become osteogenic, chondrogenic, or osteoplastic.

Circulation of the Head of the Femur Following Fracture (in Dogs). Dr. Charles J. Frankel [4] and Dr. Paul Derian studied the circulation of the femoral head in dogs after fracture and internal fixation of the femoral neck. When the femoral neck was fractured and the capsule of the hip joint stripped, aseptic necrosis of the femoral head followed. However, if muscle pedicle grafts were applied to the proximal fragment, aseptic necrosis did not occur. Seven dogs with the pedicle grafts showed beginning union at intervals of twelve to thirty-two days after fracture, and four other dogs with this treatment showed clinical union thirty-six days after fracture. Three dogs so treated were sacrificed four to six days after fracture; there was no evidence of healing at this time. The uptake of radioisotopes by the femoral head in these dogs was also studied.

The Production of Mandibular Fractures. A Study Using the Stresscoat Technique and High-Speed Cinematography. Dr. Donald F. Huelke [5] reported studies of the mechanism of mandibular fractures, using specimens of the mandible sprayed with stresscoat lacquer. The condyles of these specimens were embedded in metal or clay, respectively, to simulate the conditions in the living state when the temporomandibular joint is firmly and loosely opposed by muscular contraction. Low-energy impact applied to the symphysis caused cracks in the lacquer, indicating inward bending of the condyles embedded in the clay and vibration of the subcondylar

1. 3395 Scranton Road, Cleveland 9, Ohio.
2. The University of North Carolina, Chapel Hill, North Carolina.
3. 8730 Lasalle Boulevard, Ville Lasalle, Quebec, Canada.
4. University of Virginia Hospital, Charlottesville, Virginia.
5. Ann Arbor, Michigan.

regions in the specimens embedded in metal. High-energy impact caused fracture. High-speed movies shown of these experimental fractures indicated the correspondence of the results of the non-destructive and the destructive tests.

Induction of Heterotopic Bone Formation by Use of Extracts Made from Bone Subjected to Passive Stasis. Dr. Billie D. Burdeaux, Jr.[6], Dr. Isaac S. McReynolds, and Dr. Kairyu Hasegawa discussed the production of heterotopic bone in muscle after injection of bone extracts prepared by the method of Levander and Lacroix. The extracts were prepared from normal bone of donor animals and from bone obtained from the limbs of donor animals subjected to prolonged tourniquet venous stasis. Both dogs and rabbits were used. In the donor animals stasis was found to produce an increase in the formation of subperiosteal bone. In dogs there was, in addition, stimulation of longitudinal bone growth, whereas in rabbits longitudinal bone growth was decreased. Slightly more heterotopic bone was produced by the extracts prepared from bone subjected to prolonged venous stasis than from normal bone. However, extensive heterotopic bone was not formed by either extract.

A Comparative Study of Tendon-to-Tendon and Tendon-to-Bone Suture Line Strength. Dr. Jack Levine [7], Dr. Abel Kenin, and Dr. Morton Spinner studied the relative strength of tendon-to-tendon and tendon-to-bone sutures at intervals of from three days to three weeks after suture of the tendo achillis or common toe-flexor tendons in thirty-five rabbits. The tendons were cut transversely and obliquely and resutured end to end or implanted into the bone of insertion. At sacrifice, at time intervals after suture, the strength of the suture line was tested by a spring balance, and the healing processes were studied in histological preparations. The holding strength of the tendon-to-bone sutures exceeded that of the tendon-to-tendon sutures at all time intervals from three days to three weeks. No histological basis for the difference in strength was found.

An Experimental Study of Lymphatic Pathways of Bone, Bone Marrow, and Joints. Dr. Paul Schutt and Dr. Ernest C. Gardner [8] described the lymphatic drainage in the limbs of dogs and rabbits after injecting a solution of Evans blue (T1824) and tracing the flow of the dye. When the dye was injected into the knee joint, the subcutaneous tissues of the thigh, and the foot pads, the dye was demonstrated in the lymphatics, blood vessels, and lymph nodes. In some instances it was possible to cannulate lymphatics and collect lymph. When the dye was injected into the cortex, marrow spaces, or epiphyses, of the long bones, no dye could be demonstrated in the lymphatics, thereby indicating the absence of lymph vessels in these areas. The findings in these experiments were demonstrated by motion pictures.

Localized Epiphyseal Arrest Following Intramedullary Papain Injection. Dr. Monroe Schneider [9] studied the chondrolytic effect of papain after injection into the marrow cavity of the tibiae of rabbits. The effects of intramedullary injections were compared with those of intravenous and intramuscular injections of this drug. Both crude and refined preparations in various doses were administered, as well as single and serial injections. Many of the intramedullary injections caused systemic changes despite the use of tourniquets, but in some instances local and total epiphyseal arrest with closure of the epiphyseal line occurred. The effects ranged from necrosis and complete separation of the epiphyseal plate to mild reversible changes in the epiphyseal cartilage.

Comparison of Calcium ^{45} and Tetracycline Localization in Bone. Dr. William H. Harris [10], Dr. Jenifer Jowsey, and Dr. Robert Jackson compared the labeling of new bone by tetracycline and calcium ^{45} by administering simultaneous intravenous injections of tetracycline and calcium ^{45} to dogs. The sites of deposition of the dye and the radioisotopes were similar, but certain differences were noted. The relation between mineral density, as demonstrated by microradiogram, and the deposition of these labels were discussed.

Articular Cartilage Chondrolysis after Injection of Sterile Bacterial Enzymes. Dr. Willard S. Hunter and Dr. Sherman S. Coleman [11] studied the effect of single and multiple

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7. 20 Plaza Street, Brooklyn 38, New York.
8. Wayne University College of Medicine, Detroit, Michigan.
9. 118 Eighth Avenue, Brooklyn 15, New York.
10. Massachusetts General Hospital, Boston 14, Massachusetts.
11. 2033 South State Street, Salt Lake City, Utah.

injections of a saline extract of staphylococci in the knee joints and intervertebral discs of rats. No pathological changes were observed in the knee joints, but progressive necrosis of the intervertebral discs, followed by new-bone formation and ultimate interbody fusion, was observed after the spinal injections. No changes occurred in control animals in which saline or a vaccine of *Micrococcus catarrhalis* was injected into the intervertebral discs. The injection of living staphylococci caused similar lesions, combined with formation of abscesses and sequestra. The pathological changes were demonstrated by roentgenograms and histological preparations.

Mucopolysaccharide Production of Synovial Cells during Organ Culturing. Dr. William B. Fischer [12] and Dr. John Torgerson described the production of mucopolysaccharides in organ-tissue cultures of synovial membranes under different conditions. Excessive manipulation of the tissue diminished oxygen tension, and improper culture media diminished the content of mucopolysaccharides. Several tissue cultures prepared from the same joint showed similar changes under like conditions. The production of mucopolysaccharides by synovial membrane from normal joints and from joints with rheumatoid arthritis was similar. In both, production was stimulated by the rheumatoid factor. Caragenin also stimulated an increased production of mucopolysaccharides.

Acid Mucopolysaccharidurıa in Heritable Disorders of Skeletal Development. Dr. Andrew E. Lorincz [13] studied the urinary excretion of acid mucopolysaccharide in several patients with multiple hereditary exostoses and in patients from one family with osteo-onchodysplasia, using a technique previously described to show the excretion of this anomalous substance in the urine of patients with Hurler's disease. An increased urinary excretion of acid mucopolysaccharide was demonstrated in the children with abnormalities but not in the unaffected children in the same family. The substance excreted had been identified as chondroitin sulphate A. An analysis of an exostosis removed from one of the children demonstrated that chondroitin sulphate A was the major polysaccharide.

Synovial-Fluid Levels of Penicillin V after Massive Oral Administration. Dr. Ben T. Bell [14], Dr. Peter Viek, and Dr. Samuel C. Santangelo described the level of penicillin in the synovial fluid of forty patients with inflammatory and non-inflammatory effusion in the knee one hour after oral administration of 2,000,000 units of penicillin V. Assay of joint fluid and serum showed that both these contained effective drug levels. The influence of probenecid administration was also studied, as well as the effects of the patient's size, the type duration of the disease, and the size of the effusion.

12. 251 East Chicago Avenue, Chicago, Illinois.
13. Gainesville, Florida.
14. 1941 Woodland Road, Abington, Pennsylvania.

HOSPITAL FOR JOINT DISEASES ALUMNI ASSOCIATION

As Prepared by Dr. Joseph E. Milgram

The Annual Meeting of the Hospital for Joint Diseases Alumni Association was held at the Hospital on November 10, 11, and 12, 1960. Members of the Alumni Association and of the hospital staff presented original papers on various phases of musculoskeletal disease.

Dr. Hubert A. Sissons of London, England, delivered the Sir Robert Jones Lecture on Thursday, November 10 at 8:30 P.M., as the highlight of the three-day conference. His topic, "Tissue Turnover in Bone", concerned the dynamic aspects of metabolism with respect to tissue composition. He pointed out that organs and tissues maintain their form and function while their component materials undergo complete (or almost complete) change in the course of normal metabolic synthesis and breakdown. Only the proportions of these components remain relatively unchanged. Despite observations on tissue turnover dating back to the seventeenth century, we have been slow to recognize the universality of metabolic turnover, and the techniques for its detailed exploration are of relatively recent vintage. The application of these techniques to bone affords the opportunity of studying a relatively slow turnover rate in a tissue on which the structural integrity of the body depends. The biological activity of the skeleton, which is such a rigid structure, is truly amazing. Dr. Sissons described the techniques and results of recent studies on the metabolic exchange of bone carried out by himself and others.

Studies on the Phosphatase Activity of Synovial Fluids in Rheumatoid Conditions. Dr. Martin A. Lehman [1], Dr. Edoardo Guariglia, and Dr. Jacob Kream stated that aside from studies of the hyaluronidases in synovial fluid, little has been reported concerning the other enzymes in joint fluid. The widespread occurrence of acid and alkaline phosphatase in various tissues prompted investigation by the authors of the distribution of these enzymes in synovial fluids obtained from patients with rheumatoid arthritis, osteo-arthritis, and internal derangements of the knee. Preliminary data derived from the study of synovial fluid obtained from seventeen patients suggest that the acid-phosphatase level is higher in rheumatoid arthritis. The synovial fluid from nine patients with rheumatoid arthritis displayed a distribution of acid phosphatase as follows: below 0.5 unit, one; 0.5 to 0.6 unit, two; 1.0 to 2.0 units, five; above 2.0 units, one. In the synovial fluid from seven patients with non-rheumatoid conditions, the acid-phosphatase values were below 0.3 unit in six, and there was 0.7 unit in an eighteen-year-old patient with an acute meniscal tear. The significance of these findings and of the findings with respect to the alkaline-phosphatase levels in the synovial fluid were discussed.

Biochemical Differentiation of Pathogenic and Non-pathogenic Staphylococci. Dr. Jacob Kream and Dr. John E. Blair [2] stated that without exception all the non-pathogenic strains of staphylococci so far studied did not produce the enzyme coagulase. The crude and semi-purified enzymes isolated from growing cultures of pathogenic strains have properties different from mammalian deoxyribonucleases. The bacterial enzyme is remarkably heat stable; has an optimum pH of about 8.6; is activated by calcium ions, but not by magnesium ions; is resistant to ultrasonic irradiation; and under the proper conditions, degrades ribonucleic acids and deoxyribonucleic acids. The isolation and study of highly polymerized deoxyribonucleic acids from pathogenic and non-pathogenic strains of staphylococci are also being carried out. No differences in the purine and pyrimidine ratios of the deoxyribonucleic acid of pathogenic and non-pathogenic strains have been detected. However, the nucleic acids of the non-pathogenic organisms show a much greater sensitivity to ultrasonic irradiation and other manipulative procedures than do the nucleic acids of the pathogenic forms. The significance of the findings was discussed.

Problems of the Knee. Dr. Charles J. Sutro [3] presented six cases, each with an unusual finding demonstrated either by roentgenographic study or by arthrotomy of the knee: lymphosarcoma of the patella, sarcoid of the synovial lining of the knee without other manifestations; traumatic infarct of a synovial nodule in pigmented villonodular synovitis; osteo-arthritis with tilting of the patella caused by a complete reduplication of one of the femoral condyles; a large osseous loose body in the popliteal bursa which caused pressure necrosis of the lining of the bursal wall; and the early roentgenographic manifestations of an osteogenic sarcoma of the tibia with presenting symptoms referable to the knee.

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3. 11 East 87th Street, New York 28, N.Y.

Histopathology of Protruded and Degenerated Intervertebral Disc (Clinical Correlation). Dr. Harold Altman [4] and Dr. Golden Selin described the histopathological changes in disc tissue removed from 120 patients subjected to laminectomy. Laceration and healing by granulation tissue were observed in both the annulus fibrosus and accessory spinal ligaments. In some instances various combinations of laceration and healing were seen. Patients with extruded intervertebral discs demonstrated a characteristic halo sign surmised to be due to a soft-tissue shadow in the region of the posterior-inferior portion of a vertebral body at the level of the extruded disc. It manifests itself on the lateral roentgenogram of the myelogram by a loss of clarity of the outline at this portion of the vertebral body. The possibility of a gas shadow from overlying bowel producing this roentgenographic finding was difficult to eliminate. On follow-up examination, from two to three years after laminectomy, a surprisingly high number of patients had residual numbness in the involved lower extremity.

Experience with Prolotherapy Treatment or Low-Back Pain and Sciatica. Dr. Abraham Myers [5] stated that prolotherapy is the injection of sclerosing solutions into ligaments or tendons to stimulate chemical inflammation and the production of fibrous tissue. Many low-back disabilities result from relaxed ligaments or so-called unstable backs. Prolotherapy is believed to strengthen weakened ligaments and to re-establish joint stability permanently; it has been shown to relieve pain. Over 300 patients were treated by this method and the results analyzed. There were no complications. The satisfactory clinical results with this method suggest that it is a positive and constructive non-operative treatment of low-back pain. The author considered prolotherapy to be a valuable addition to the traditional therapeutic regimen for low-back disability and suggested that it warrants further consideration by orthopaedic surgeons.

Acute Traumatic Extrusion of the Acromioclavicular Meniscus. Dr. Joseph E. Milgram [6] presented a case report of the course and operative findings in this syndrome, reviewing the findings in the original case described by Friedmann.

Scapulo-Thoracic Positioning. Dr. Joseph E. Milgram [6] stated that the position of the scapulohumeral complex on the thorax is normally determined by the clavicle. The normal frontal position of this complex may be changed to a sagittal position either by changing the shape of the clavicle by osteotomy or by removing all or part of the clavicle. Congenital forward shoulders or quadrupedal scapulae, which are sagittal in position, can be brought into the normal frontal position by multiple splintering longitudinal osteotomies of the clavicles followed by a three-point-pressure, plaster-of-Paris yoke to maintain position until clavicular union is achieved. Malposition of the humerus on the scapula with loss of adduction resulting from traumatic or infectious stiffness of the shoulder joint can be corrected easily by displacing the scapula on the thorax from the frontal to the sagittal plane after resection of the outer end of the clavicle. After arthrodesis of the shoulder, increased scapular-thoracic motion can be provided by resection of the outer end of the clavicle. When this procedure is performed in patients with paralysis, the trapezoid and coronoid ligaments are preserved. Resection of the outer end of the clavicle is not recommended for women with paralysis because of the unsightly defect that results from this procedure.

The Pathology and Treatment of the Game-Keeper's Thumb. Dr. Emanuel B. Kaplan [7] stated that game-keeper's thumb is a subluxation of the first metacarpophalangeal joint with radial deviation of the proximal phalanx. The deformity was thought to result from a rupture of the ulnar collateral ligament of the metacarpophalangeal joint, but observations at operation and the experimental reproduction of this deformity in cadavera have demonstrated that the subluxation is produced by a disruption of the dorsal apparatus of the thumb with migration of the adductor pollicis insertion with its sesamoid in a volar direction and displacement of the extensor pollicis longus tendon to the radial side of the first metacarpal. The treatment requires replacement of the sesamoid and the adductor pollicis insertion and return of the tendon of the extensor pollicis longus to its normal position. A method of treatment was described.

Ameloblastoma. Dr. Alvin S. Nathan [8] presented the differential diagnosis of ameloblastoma and discussed its etiology and pathology in relation to treatment. An illustrative case of a tumor which eventually became malignant and metastasized was presented.

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6. 1919 Madison Avenue, New York 35, N.Y.
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8. 19 Garfield Place, Cincinnati 2, Ohio.

Operative Treatment for Recurrent Dislocation of Temporomandibular Joint. DR. CAROLL M. SILVER [9] and DR. STANLEY D. SIMON stated that recurrent dislocation of the temporomandibular joint is an infrequent but disabling condition. Surgical treatment is the only therapy of practical value in the well established case. Of the multiple surgical procedures available, the authors consider partial section of the insertion of the external pterygoid muscle combined with meniscectomy as the procedure of choice. This was proposed originally by Boman in 1949. Two cases were presented: one with a follow-up of four and one-half years, the other with a follow-up of five months. There was no recurrence in either patient and the clinical results are considered good. The surgical technique and aftercare were described.

The Use of Intramedullary Nailing in the Long Bones. DR. RICHARD L. FENTON [10] said that intramedullary nailing of the long bones is useful in the treatment of fractures, for a fracture that would be very difficult to treat by other methods can often be turned into one that is relatively simple to treat by the proper use of intramedullary nailing. The type of intramedullary nailing and the method of repair should be varied with the individual case, instead of adapting each case to one specific type of intramedullary nail. There are certain advantages in the use of the Küntscher intramedullary nail for the femur; however, the Küntscher nail for the tibia is not particularly effective, a diamond-shaped intramedullary nail being more appropriate. By the same token, a Rush nail is most advantageous for the humerus and diamond-shaped, malleable intramedullary nails are most suitable for the ulna and radius. A series of cases was presented to demonstrate the use of the different types of intramedullary nails, as well as circumferential wires and tangential screws as additional fixation. Early mobilization and weight-bearing are made possible by this method of fixation and are even helpful in speeding early healing of the fractures.

A New Test for Fluid in the Knee Joint. DR. H. ARCHER BERMAN [11] presented his experiences with a test for the determination of the presence of fluid in the knee joint, with a short movie demonstrating the test. Only a few minutes are required to perform the test, which is particularly effective in the demonstration of minimum or moderate effusions. The test cannot be performed in the presence of a large effusion and is actually not necessary because the effusion is evident even to the patient. This test is of value because it can be demonstrated to a non-medical group such as a jury, to an auditor in a jury-waived court case, or to a commissioner in an industrial accident case. The test consists in simply exerting pressure with the flat of the hand on the medial side of the knee, forcing the fluid over to the lateral compartment. Then, with a quick push of the opposite hand on the outer side of the knee, the fluid is forced back into the medial compartment, causing it to baloon. The medial compartment remains filled even though both hands are removed. The patella must be relaxed in order to perform this test.

Hip Problems: Procedures at the Hospital for Joint Diseases (1951–1957). DR. HERMAN ROBBINS [12], DR. PAUL A. JACOBS, and DR. HAROLD SEIDENSTEIN (deceased) presented a statistical analysis of the results of three operations for pathological conditions of the hip. Their study indicated that there is no one procedure suitable for the treatment of all hip disease. Two factors, age and the extent of the pathological involvement of the acetabulum, were most important in the eventual outcome of these procedures. In younger people with osteo-arthritis, the majority of good results were observed after resection angulation and arthrodesis. In patients over fifty years of age arthrodesis did not give good results, nor did a prosthesis or resection angulation solve the problem, although the prosthesis gave somewhat better results. The results in patients of all ages with acute fractures, non-union, and avascular necrosis demonstrated the efficacy of the prosthesis. These patients did well. Fusions performed, when well indicated, for various pathological conditions (poliomyelitis, sepsis, and tumor) yielded excellent results in patients under fifty years of age.

The Efficiency of Internal Fixation for Fracture of the Femoral Neck. DR. VICTOR FRANKEL [13] reported on tests of the strength of osteosyntheses of femoral-neck fractures. A load placed on the femoral head of an intact femur is transmitted through the neck to the shaft. After fixation of a fracture of the femoral neck, the load must be transmitted partly through the appliance and partly through the bone. Loading of the femoral head produces a bending moment. The total

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bending moment was calculated for the load acting on the head. The part of the bending moment transmitted through the appliance was found experimentally, using strain-gauge techniques. The bending moment transmitted through the bone was calculated by subtracting the measured bending moment on the appliance from the calculated total bending moment. The direction of the fracture line influenced the proportion of bending moment transmitted through the bone. Doubling the stiffness of the appliance doubles the amount of bending moment transmitted through the appliance. Compression of the fracture site influenced the bending moment transmitted through the bone to only a slight extent. New nail-plate designs based on the findings in the reported experimental work were demonstrated.

Clinical Pathologic Conference. Dr. Austin D. Johnston [14], Dr. Henry L. Jaffe, and Dr. Hubert A. Sissons [15] presented several cases to illustrate the effects of radiation on bone and discussed certain aspects of radiation-induced neoplasms. Some attention was given to the general alterations in the affected tissue. The effects of radiation were demonstrated by the morphological changes in an irradiated pigmented villonodular lesion, comparing the morphology of this lesion to that of a similar lesion not subjected to irradiation. The authors also discussed some of the deleterious effects of cortisone administration on bone and joints, presenting three illustrative cases. Several cases observed in England by Dr. Sissons demonstrated bone destruction in metabolic diseases.

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AMERICAN SOCIETY FOR SURGERY OF THE HAND

The Sixteenth Annual Meeting of the American Society for Surgery of the Hand was held on January 6 and 7, 1961, in Miami Beach, Florida, under the Presidency of Dr. Daniel C. Riordan of New Orleans, Louisiana.

Summaries of the papers read follow:

January 6

A Quantitative Study of the Vascular Beds of the Hand. Dr. J. E. Markee [1], Dr. J. G. Nork [2], Dr. J. B. Wray [3], and Dr. F. McFalls [4] presented a study of the vascular beds of the hand. They utilized the injection of the total bed with methylmethacrylate, digestion of the tissues, and separation of the component parts of the various beds and the determination of their weights. Certain quantitative relationships of the human hand were studied; namely, the percentage of its volume constituted by dermis (22 per cent), muscle (15 per cent), tendons (10 per cent), bone (37 per cent), and connective tissue (15 per cent), and the amount of the vascular bed located in each of these components. In three of the 100 hands utilized, the weight and, indirectly, the volume of a plastic cast of the vascular spaces was determined. The vascular space constituted about 11.8 per cent of the total volume of these three normal hands. By dissecting these casts it was determined that the vascular bed was distributed as follows: 47 per cent within the connective tissue, 21 per cent within the bones, 1 per cent within the dermis, 13 per cent within the muscles, and 2 per cent within the tendons.

The distribution of the small, medium, and large vessels within each of these tissues of the hand was determined by teasing the cast apart and weighing separately the fragments with diameters less than 134 micra, with diameters between 134 and 536 micra, and with diameters larger than 536 micra. In the dermis, muscle, periosteum, and bone, 75 to 85 per cent of the vascular bed was found to be made up of vessels with a diameter less than 135 micra; whereas in these same tissues, vessels with a diameter greater than 536 micra made up respectively 4 per cent (dermis), 10 per cent (muscle), 10 per cent (periosteum), and 5 per cent (bone) of the vascular beds.

Tissues with a low metabolic rate were supplied by fewer small vessels and transmitted a disproportionate number of large vessels. Thus, in tissues such as the dorsal connective tissue, nerves, and tendons, the small vessels constitute only 51, 67, and 50 per cent, respectively, of the vascular bed; whereas, the vessels larger than 536 micra made up 38.5 and 41 per cent of the vascular bed.

In discussion, Dr. Herbert Conway [5] stated that the authors' excellent work is a classic example of the application of quantitative methods of the anatomy and physiology of the hand.

Dr. Emanuel B. Kaplan [6] considered this work extremely valuable, stating that it will be of some use in advancing other studies, such as the distribution of the abnormal perivascular and intravascular tissues of the hand and the anatomical distribution of the nerves which control these vessels.

Repair of Atomic, Cathode, Cyclotron and X-ray Burns of the Hand: Long-Term Follow-up with Microscopic Studies. Dr. M. P. Fryer [7] and Dr. J. B. Brown [8] compared burns of the hand suffered from atomic energy, cyclotron, and cathode-ray machines with those from ordinary x-ray or radium. Atomic-energy burns appeared to cause pathological changes similar to x-ray burns, but in a much reduced period of time. Cathode-ray machines were found to emit beams of electrons that would cause hand injuries with delayed blistering and late, full-thickness loss of skin.

From the authors' experiences they were encouraged to continue a conservative plan of management. Fingers had been saved and function of hands maintained by anticipating progressive breakdown and being prepared for relatively early resection and grafting. It was not stated how many of these unusual types of burns had been seen or treated by the authors.

Dr. Arthur J. Barsky [9], in discussion, pointed out that with the increased use of nuclear power for industrial purposes, surgeons must be prepared for an increase in the number of atomic injuries and agreed with the principle of conservative management of these injuries. He reported on a case of x-ray injury from a fluoroscope in a surgeon's hand which was successfully grafted; two years later, however, the grafts on several fingers broke down and flaps were required.

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DR. JULIAN M. BRUNER [10] said that the destructive biological effects in some modern uses of energy are produced by mixed radiation, including gamma rays, neutrons, and alpha and beta particles in various proportions. In some cases, thermal factors may be added.

DR. BRADFORD CANNON [11] emphasized the potential dangers inherent in all types of radiation. He pointed out how actually few in number were the injuries from high-energy irradiation in the past eighteen years in contrast to the terrible toll among early workers in x-radiation. He referred to a personal series of 165 patients with irradiation damage, 22 per cent of whom had proved carcinoma. The average time after irradiation before the carcinoma was diagnosed was twenty-eight years.

Electrical Injury to the Hand. DR. CLIFFORD C. SNYDER [12] pointed out that the number of electrical injuries is increasing each year and that the hand is often the point of entry of the current. He said that the passage of current through the body can produce an intense heat wherever it encounters the most resistance. Emphasis was placed on débridement one and two weeks after the injury, with an immediate full-thickness flap coverage, when possible.

Nerves should be sutured shortly after the wound is healed, but the physiological limit of nerve tension is less than the anatomical limit and to avoid excess tension, nerve grafts should occasionally be used. A pedicle nerve graft was suggested to bridge areas of great fibrosis and poor circulation. Either the proximal or distal end of the donor nerve may be used as the pedicle graft.

DR. DARREL T. SHAW [13], in discussion, stated that he had not used the pedicle transplantation of the ulnar nerve for restoration of the median nerve. He wondered if the blood supply is really adequate in such circumstances. He pointed out that Dr. Snyder's use of the abdominal pedicle for thumb reconstruction had been disappointing in his (Dr. Shaw's) hands and that whenever possible he prefers even a very short thumb stump covered with normal hand tissue.

DR. LOT D. HOWARD, JR.[14], said that Lewis described three effects of electricity on the body: (1) direct stimulation causing violent muscular contraction that may even produce fractures or the temporary physiological block of nerve centers, resulting in alteration of nerve conductions or paralysis; (2) the physiochemical effect resulting from ionization by the electrical current; and (3) the effect of heat generated where the electricity meets resistance as it passes through the body. Dr. Howard feels that effects of heat produce the main problem in reconstruction. At the site of exit or entrance of the electrical current, where a spark occurs, the temperature may rise briefly to 3,000 degrees centigrade or above. He pointed out the similarity of major electrical burns of the hand and forearm to the clinical picture seen in Volkmann's contracture. He emphasized the difficulty in knowing just how much tissue required débridement at any particular time.

DR. W. H. FRACKELTON [15] called attention to the work of Hyslop and Miller (Treatment of Electric Burns. J. Int. Coll. Surgeons, **23:** 481–486, 1955). This work suggested that the condition of the skin did not give an accurate early idea of the amount of deep damage, but that the pattern of thrombosis of the deep veins would outline rather accurately the larger area of deep necrosis. Also, the devitalized muscle would show a chocolate color early, surrounded by a rim of subcutaneous edema similar to that seen in the skin. Even with these criteria, early débridement was subtotal and therefore did not permit use of a pedicle flap immediately after the electrical burn; it would be wiser to use a split graft whenever possible in the early phase.

DR. ERLE E. PEACOCK, JR. [16], stressed the fact that the surgical literature is full of descriptions of free nerve grafts and pedicle nerve grafts but that there is little description of the final results. He urged the Society to adopt a more critical attitude toward evaluating various procedures of nerve restoration.

DR. SNYDER closed the discussion by emphasizing that true electrical burns are rather rare. He had had experience with fourteen cases and in nine of these there had been some replacement of the sweat glands after nerve repair. He stated, "these people are able to feel an object but they cannot tell whether it is round or flat".

Injury of the Median and Ulnar Nerves, 150 Cases, with an Evaluation of Moberg's Ninhydrin Test. DR. W. B. STROMBERG, JR. [17], DR. R. M. MCFARLANE [18], DR. JOHN L. BELL [19],

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16. University of North Carolina, School of Medicine, Chapel Hill, North Carolina.
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18. 154 East Erie Street, Chicago 11, Illinois.
19. 154 East Erie Street, Chicago 11, Illinois.

DR. MICHAEL L. MASON [20], DR. SUMNER L. KOCH [21], and DR. OTTO BOUC [22] analyzed 150 cases of injury of the median and ulnar nerves, but excluded from study those cases that were unfavorable because of tension at the line of nerve suture or delayed repair. Thirty of the 150 hands were examined as long as five years after operation. Twenty-four of the thirty had normal ninhydrin prints. Moberg's pick-up test was performed on twelve, and good function found in only four.

The authors found that sweating and response to pinprick invariably returned together. Completely normal sensation is rare after repair of the median and ulnar nerves. The best tests of normal sensation are two-point discrimination and tactile gnosis. The authors believe that it takes at least five years in the adult and one to two years in children for return of normal or near normal sensation after median and ulnar-nerve suture (presumably when divided at the wrist level). They felt the main value of the ninhydrin test is its objectivity.

A Long-Term Follow-up Study of 180 Cases of Civilian Peripheral Nerve Injuries. DR. HARILAOS SAKELLARIDES [23] studied 180 nerve injuries in 152 patients. In most of these injuries either primary or secondary suture or resuturing of the nerve had been carried out. In both median and ulnar-nerve repairs, secondary sutures gave results superior to those after primary suture. In the case of the radial nerve, both primary and secondary sutures showed equally good results.

It should be noted that in most of the groups, the number of cases compared was quite small. The author felt that primary repairs of the median and ulnar nerves should be carried out at a low level only if the surgeon is well trained in the technique for the repair of peripheral nerves, if the laceration is a clean one, and if all facilities are available for good surgery and assistance.

The last two papers were discussed together.

DR. J. EDWARD FLYNN [24] stated that three grades of sensation could be differentiated according to grip: (1) precision sensory grip, (2) gross grip, and (3) protective sensibility.

He felt that the best objective test for showing precision sensory grip was the ninhydrin test. He reported 20 per cent excellent, 50 per cent fair, and 30 per cent poor results from suture of the median nerve at the wrist. Identical figures were reported for sensory return of the ulnar nerve when repaired at the wrist. With motor return after ulnar-nerve repair, however, he found no excellent results, 8 per cent good, 15 per cent fair, 57 per cent poor, and 20 per cent failures. Thus, he agreed with the authors of the two preceding papers that normal sensation was rarely obtained after ulnar or median-nerve repair, but that protective sensibility was found in 90 per cent of the hands and useful function in 70 per cent. With both median and ulnar-nerve repairs, tendon transfers were used in 30 per cent of the patients.

DR. WILLIAM H. FRACKELTON [15] reminded us that Moberg said that the ninhydrin fingerprinting test will map out the tactile gnosis necessary for the precision sensory grip, which a qualified surgeon must learn in order to evaluate this type of disorder to plan a program of reconstruction. Hand surgeons should hope that Moberg's test would give an objective method of evaluating tactile gnosis. He pointed out that the work of Stromberg and his colleagues did not support Moberg's original contention and that the ninhydrin test is not correlated with excellent qualitative sensory return.

Dr. Frackelton pointed out the value of this type of test in a young child unable to cooperate in other forms of sensory testing. He was somewhat critical of the use of the terms good, fair, and poor to evaluate motor and sensory function and urged that tests be established which would be sufficiently objective to be reproducible in the hands of all serious observers. He felt that at present no simple objective nerve test for functional evaluation after repair had been brought forward.

DR. PAUL BRAND [25] urged not only the use of objective medical tests of sensory function after nerve repair, but also sampling of the patient's ability to carry out work which might demand the use of his partially anesthetized or partially paralyzed digits. He suggested the use of a coin attached to a fisherman's spring balance. By asking the patient to hold the coin between his finger and thumb, the observer then pulls on the spring balance and measures the tension to draw the coin from between the fingers. In the absence of sensation in these fingers motor power is also diminished in such a test. Perhaps this is due to the unevenness of the finger grip from anesthesia.

Dr. Brand pointed out finally that if the same person is asked to grasp a larger or more stable object than the coin, he may even exert motor power greater than normal, possibly because of the absence of pain or discomfort associated with the squeezing force.

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23. Massachusetts General Hospital, Boston 14, Massachusetts.
24. 412 Beacon Street, Boston 15, Massachusetts.
25. Leper's Hospital, Vellore, India.

Congenital Absence of the Ulna. Dr. Daniel C. Riordan [26], Dr. Edward H. Mills [27], and Dr. Rufus H. Alldredge [28] surveyed the literature and presented sixteen additional cases of congenital absence of the ulna. In their opinion the wedge-shaped distal radial epiphysis and the bowing of the radius, as well as the increasing ulnar deviation of the hand, are caused by a non-growing fibrocartilaginous remnant of the ulna which prevents a straight longitudinal growth. In those cases where a movable joint was present, the head of the radius usually was dislocated posterior to the humerus, and the longitudinal growth contributed by this proximal radial epiphysis was wasted in the soft tissues. This too was thought to be the result of the non-growing fibrocartilaginous remnant of the ulna.

The plan of treatment recommended by the authors was as follows:

1. From birth to six months: correction of the deformity by a plaster cast and maintenance of as much correction as possible with a plaster splint or brace;

2. After the age of six months, if the child's health permits: resection of the fibrocartilaginous ulna distally. At the same time the radius should be swung over and fused to the ulna at the elbow, if the radial head is already dislocated. If the radial head is not dislocated, the radius need not be swung over into the ulna. If seen early enough a stable elbow may result from this type of treatment. If the radial head subsequently dislocates, then the radius should be swung and fused to the ulna, making a one-bone forearm with the ulna at the elbow and the radius at the wrist, giving stability at these two joints;

3. In some patients, especially those in an older-age group, a wedge osteotomy to correct the radial bow may be necessary in addition to the procedures just recommended;

4. In those patients with a fusion of the radius to the humerus and no elbow motion, a resection of the fibrocartilaginous ulna in its distal portion is still recommended and a wedge resection to correct the radial bowing is usually necessary.

The authors made a plea for early treatment as it was felt that the severity of the deformity could be lessened by early treatment and a greater amount of longitudinal growth would result from the procedures.

Use of Synergistic Transfers in Spastic and Paralytic Hands. Dr. Mark H. Greene, Jr. [29], discussed tendon transfers about the hand and wrist with respect to synergistic units of function. These synergistic functions are basic and occur automatically with mutual participation, one force stabilizing a part while the other force flexes or extends a part.

When tendons can be transferred within their own synergistic units, postoperative re-education is minimum and hand function is strengthened. Three such synergistic units have available tendons for transfer: (1) finger flexors and wrist extensors, (2) wrist flexors and finger extensors, and (3) thumb flexors and thumb extensors. Synergistic movements in the hand are basic movements and surgeons should try to supplement these movements whenever one of the units of a function is deficient.

Dr. S. Benjamin Fowler [30], in discussion, stated that synergy means nothing more than working together. Hand functions are complex. In cerebral palsy, synergistic movements are interfered with to a greater or lesser degree, depending upon the severity of brain damage. People with cerebral palsy have no ability to alter phase contractions or to re-educate the muscle of the transplanted tendon.

Prolonged splinting after tendon transfer may well be the essential ingredient in the patient's, improvement.

Dr. J. Leonard Goldner [31] went on to state that the decision as to what to do with a disabled hand in cerebral palsy is much more difficult than in paralytic poliomyelitis. The use of the sublimi is limited. He disliked taking the sublimis away from the index finger. The sublimi of the long and ring fingers are good for transfer but the sublimis of the little finger is not of much use. Some of our best hands have resulted from transfer of the extensor carpi radialis longus into the finger flexors, the wrist flexors, or the finger extensors.

Any combination may be good, but some are better than others; one should use whatever is available to accomplish what is desired. With transfers in spastics, it is better to plan to do a wrist fusion a year or so later.

Transfer of the Extensors of the Wrist and Digits to Restore Opposition of the

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30. 1919 Hayes Street, Nashville 4, Tennessee.
31. Duke University Medical Center, Durham, North Carolina.

Thumb. Dr. Edward D. Henderson [32] stated that in instances in which flexor muscle power is not available for use in the standard transfers to restore thumb opposition, the wrist extensors may be used for this purpose. In twelve hands treated by this procedure it was found that satisfactory or better results were obtained. Two attempts to use the brachioradialis muscle were failures. Best results were obtained by passing the extensor carpi radialis longus or brevis tendons around the ulna without a pulley, elongating it by a tendon graft attached to the thumb by the method of Riordan. It is necessary to have normal passive motion and good power in flexion, extension, and abduction of the thumb before doing transfers to restore opposition. Since the excursions of the wrist extensors and the abductor pollicis brevis are probably nearly equal, and since their functions in ordinary hand movements are synergistic, it seems likely that the tendons of these extensors can be used satisfactorily as power for restoration of opposition of the thumb. Experience at the Mayo Clinic tends to show that the extensor carpi radialis longus or brevis, routed around the ulnar border of the forearm and elongated by a tendon graft across the volar aspect of the wrist to the thumb, provides very satisfactory thumb opposition. Less successful results seem to be obtained by using the extensor carpi ulnaris, suturing the active tendon to the extensor pollicis brevis, or by passing the tendon around the radial side of the forearm. Dr. Henderson and his colleagues prefer the method of Riordan for the attachment of the transfer to the thumb. They believe that the best results of the wrist-extensor transfers rival those of the best of other methods. The brachioradialis transfers are not satisfactory, probably because of the short excursion of this muscle. It seems likely that the extensor indicis proprius or extensor digiti quinti might also be used for restoration of thumb opposition. Active flexion, extension, and abduction of the thumb are necessary to restore opposition and they must be present or restored before the opponens transfer will be successful.

In discussion, Dr. William L. White [33] stated that he used the extensor carpi radialis longus as the motor with a plantaris tendon graft ten to twelve inches in length to span the distance from the thumb and the motor. The point of proximal juncture can then be made high on the dorsum of the forearm, away from the binding points of the wrist and ulna, and the distal end of the tendon graft can be attached to the thumb in any conventional manner. The tendon graft should be passed subcutaneously.

Dr. T. Campbell Thompson [34] stated that a good, strong sublimis muscle makes the best motor for restoration of opposition and the strongest one should be used. In severely disabled hands restoration of opposition is a most difficult problem.

A Follow-up Study of Reconstructive Procedures to Produce Mobility or Stability of the Paralyzed Thumb. Dr. Paul Brand [35] dealt chiefly with the difficulty encountered in stabilizing a badly paralyzed thumb by tendon transfers. He stressed the value of fusion of the metacarpophalangeal joint of the thumb as a primary method of treatment and as a method of salvaging poor results of tendon transfers.

Indications for Prosthetic Replacement for Rheumatoid Finger Joints. Dr. Adrian E. Flatt [36] reported on his investigations, begun in 1958, of the use of prostheses in finger joints disabled by rheumatoid arthritis. During the first two years, thirty joints were replaced, more prostheses being inserted into the proximal interphalangeal joints than into the metacarpophalangeal joints. Although the follow-up was too short for definitive conclusions, Dr. Flatt felt that sufficient observations had been made to define those cases which appear to be suitable for joint replacement and those cases in which the procedure is contra-indicated. Dr. Flatt demonstrated his use of a modified Brannon prosthesis, pointing out that the double-pronged stem accommodated better to the shaft of the phalanges and metacarpals and prevented rotation.

The author stressed the fact that the insertion of a prosthesis must be considered as one part of the whole program for the rehabilitation of the rheumatoid hand. Placing of a prosthesis must invariably be combined with other procedures. When combined with an intrinsic release, the prosthesis is of particular value in the restoration of function in the stiff proximal interphalangeal joints of hands with intrinsic-plus deformities. In the metacarpophalangeal joint the prosthesis supplied stability at the cost of lateral mobility; the prosthesis has been particularly useful in restoring a functional range of motion to completely dislocated joints.

Dr. James N. Wilson [36] agreed that some type of prosthesis for the rheumatoid hand should be in our surgical armamentarium and that our major problem will be how and when to use such a device. In the severely crippled hand with the metacarpophalangeal joint destroyed or dislocated

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33. Medical Arts Building, 3700 Fifth Avenue, Pittsburgh, Pennsylvania.
34. 535 East 70th Street, New York 21, N. Y.
35. University Hospitals, Iowa City, Iowa.
36. 1401 South Hope Street, Los Angeles 15, California.

and marked ulnar drift of the fingers combined with rigid proximal interphalangeal joints, reconstructions of the joints, soft-tissue releases, and arthrodesis may improve appearance but rarely enhance function. In this type of hand, joint replacement would be the only recourse. Dr. Wilson described and discussed the single-stemmed self-broaching articulated device designed by his associate Dr. Joseph H. Boyes [37]. Although this prosthesis had given satisfactory results in several cases, the complication of rotation because of the device's single stem had been observed in others.

Dr. Paul R. Lipscomb [38] expressed his gratitude to Dr. Flatt for his guarded approach limiting the use of these appliances to very carefully selected patients and for his careful appraisal of his results, including the complications. He pointed out that in Dr. Flatt's series the prosthesis was used in the proximal interphalangeal joint in less than 18 per cent of the total number of surgical procedures and that in the metacarpophalangeal joint it was used in less than 9 per cent. Dr. Lipscomb cautioned against indiscriminate use of the prosthesis and pointed out the bitter experience that followed the widespread use of the femoral-head prosthesis soon after its introduction. It was Dr. Lipscomb's impression that when he restores these rheumatoid fingers to positions of function by performing arthroplasties on the proximal joints and arthrodeses on the middle joints, function improved rather than decreased with the passage of time. Fixed swan-neck deformities must be corrected. In some cases division of the central slip, dorsal capsulectomy, and, perhaps, excision of the collateral ligaments will accomplish this end. Some will respond to gentle manipulation at the time of surgery on the proximal joints. Boutonnière deformities have not resulted, provided the digits are splinted in the position of function for three weeks after soft-tissue release. Since the wrist is the key joint of the hand, any flexion deformity at the wrist must be corrected first if the best possible function is to be obtained from correction of the deformities in the smaller, more distal joints regardless of the treatment used.

Dr. Flatt, in closing the discussion, stated that bone absorption around the neck of the prosthesis had been observed when this device had been in place three or four years. There is no doubt that the bone is giving away at the metal-to-bone contact. A prosthesis placed in young people of twenty will not be *in situ* when they are forty. This is an interim work and, perhaps, over the next twenty years, something else will be worked out. Until that time the indication for the use of these prostheses is probably very limited.

Fractures of the Hand: A Follow-up Study. Dr. W. D. Butt [39] reported on a statistical review of fractures of the hand for the years 1955, 1956, and 1957, as recorded in the files of the Workmen's Compensation Board of Ontario. A clinical follow-up was made of specific fractures of the metacarpals and of the distal, middle, and proximal phalanges. Roentgenograms and photographs were made and the patients examined at their homes and places of employment. Soft-tissue injury associated with the fractures produced the major portion of loss of function of the hand. Metacarpal fractures generally healed with little disability regardless of the type of treatment. Some shortening and angulation at the fracture site could be tolerated, but not rotation. After Bennett's fracture-dislocation there were good functional results even with some articular deformity. In the distal phalanx there were three main types of fracture according to the type of injury—laceration, crushing, or avulsion of the extensor tendon. Special care was needed in treatment of the avulsion of the extensor tendon. The disability associated with fractures of the middle phalanx was due to the crushing trauma which frequently produced a loss of the center of the shaft of the middle phalanx or gross displacement of the fragments. The proximal phalanx had a constant U-shaped deformity with the fracture site open on the volar surface. The resultant disability was constant, with a flexion deformity of the proximal interphalangeal joint amounting to as much as 90 degrees. It was this fracture in the center of no man's land of the flexor tendons which was studied further by producing experimental fractures of the proximal phalanx of monkeys and making a sagittal section of the fracture site one month later. These sections showed that there were osseous-fibrous adhesions between the callus at the fracture site and the extensor and flexor tendons.

In discussion, Dr. Robert D. Larsen [40] pointed out that all metacarpal fractures do not necessarily do well and pleaded for better immobilization. Skeletal traction is preferred to traction through the pulp. Correct rotation of the metacarpal fragments must be maintained. For the best results open reduction and Kirschner-wire fixation may be needed at times both in metacarpal and phalangeal fractures.

Dr. Donald B. Slocum [41] commented that it is interesting what good function can be achieved despite inadequate reduction; the difference between excellent and acceptable results should be

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38. Mayo Clinic, Rochester, Minnesota.
39. Medical Arts Building, Toronto 5, Ontario, Canada.
40. 1405 Kales Building, Detroit 26, Michigan.
41. 431 Eugene Medical Center, Eugene, Oregon.

clearly stated. Just because the patient returns to his former occupation does not mean that he does not have disability. This criterion for disability should only be used with reservation. Adaptation may disguise a disability.

Disability in the industrial sense means that the workman has a handicap in performing any type of work.

The History of Flexor-Tendon Grafting. Dr. Jerome E. Adamson [42], Dr. Joseph H. Boyes [37], and Dr. James N. Wilson [36] presented a comprehensive review beginning with the influence of Galen, Avicenna, and others on the anatomy and surgery of tendons. Even though the famed Arabian surgeon, Avicenna, in the tenth century described and taught tenorrhaphy, the very early writings of Galen discouraged the ancient surgeons from attempting tendon repair. The studies of the Renaissance surgeons—Roger of Parma, Guy de Chauliac, and others— were mentioned and the advances and contributions of Lexer, Stoffel, Kirschner, and other early leaders of modern orthopaedic surgery were also discussed.

The authors said that the classic physiological and anatomical contributions of Biesalski and Mayer prepared the way for modern flexor-tendon grafting. They also presented an interesting story of the development of the flexor-tendon graft. The contributions of the present-day leaders in this field were reviewed and modern experimental studies of the flexor sheaths, tunnels, and prostheses were interestingly woven into this historical account.

Saturday, January 7

Rhabdomyosarcoma of the Hand. Dr. Austin D. Potenza [42] and Dr. Donald J. Winslow [44] reviewed the clinical and pathological findings, differential diagnosis, and treatment of twelve cases of rhabdomyosarcoma in the hand. Three of these cases which were found in an extensive review of the literature were analyzed with the authors' cases. The group of twelve cases included nine alveolar rhabdomyosarcomata, one of which was probably congenital in origin; two cases of pleomorphic rhabdomyosarcoma; and one case of the embryonal form of the tumor. Three primary forms of treatment were used: amputation, simple or radical local excision, and x-ray therapy. Of the twelve patients, ten died of the disease, one with metastases was lost to follow-up, and one was lost to follow-up after local excision. In those patients with complete follow-up, it has been a uniformly fatal disease, regardless of treatment.

Dr. Robert E. Carroll [45], in discussion, presented a case of a twelve-year-old girl who was operated on for rhabdomyosarcoma on the volar aspect of the metacarpophalangeal joint of the second ray. A radical ray excision left her with a useful hand. A colored transparency, made four years after surgery, indicated an excellent hand with no sign of local recurrence. Dr. Carroll made a plea that whenever possible partial radical resection be carried out instead of total amputation, since no better result was obtained after total amputation of the hand than after radical resection. Since the disease is universally fatal and since there is extreme difficulty even for experienced pathologists in making a correct diagnosis, conservative treatment is indicated.

Dr. Lee Milford [46] stressed the rarity of this type of tumor and the difficulty in diagnosing it. The diagnosis, according to some pathologists, can be made without the demonstration of transverse striations in the tumor cells, which are most difficult to find, but can be based on the characteristics of the tumor cells.

Dr. Winslow, in closing, stated that after personally examining ten or twelve alveolar tumors in the Soft Tissue Section at the Armed Forces Institute of Pathology, he was impressed with the fact that when this type of rhabdomyosarcoma occurs, it seems to be located in the short striated muscles. This may be the reason for the large preponderance of this particular rhabdomyosarcoma in the hand. The author had observed this same type of rhabdomyosarcoma in the intercostal muscles.

Reconstruction of the Thumb. Dr. J. Edward Flynn [14] and Dr. C. Nason Burden [47] discussed reconstruction of the thumb by phalangization, bone transplant and tube pedicle graft of the skin, pollicization, pollicization on a neurovascular pedicle, and other minor procedures. They emphasized that an amputated thumb causes an estimated loss of 50 per cent of the function of the

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43. Department of Experimental Surgery, Walter Reed Army Institute of Research, Washington 12, D. C.
44. Department of Pathology, Armed Forces Institute of Pathology, Washington, D. C.
45. 180 Fort Washington Avenue, New York 32, N. Y.
46. Campbell Clinic, 869 Madison Avenue, Memphis, Tennessee.
47. 68 Church Green, Taunton, Massachusetts.

hand. A hand without a thumb is, at best, only a useful hook. A partial amputation of the thumb distal to the metacarpophalangeal joint usually requires nothing more than a well padded stump which is not adherent to bone and has no neuroma. An intact thumb may be so adducted by skin and muscle contracture that it is rendered useless. Satisfactory correction of this deformity can usually be achieved by excision of the scar; stripping of the attachment of the adductor pollicis tendon, moving its attachment proximally; and use of a long diamond-shaped pedicle flap. A thumb amputated near the metacarpophalangeal joint may have so much scar and contracture about the cleft that the thumb is useless. If the amputation is at the metacarpophalangeal joint, a useful thumb can be obtained by deepening the thumb-index cleft. In some instances amputation occurs through a point in the first metacarpal that leaves the intrinsic muscles of the thumb intact; in others, the entire thumb ray may be amputated. Under these circumstances reconstruction of the thumb is desirable by graft with a thick pedicle of skin or pollicization on a neurovascular pedicle of any one of the other fingers, including the little finger. For the ideal result, the new thumb should have motion, proper position, and good sensation with stereognosis.

In discussion, Dr. J. William Littler [48] emphasized that the little finger was not the usual choice to replace partial loss of the thumb. The use of the next most independent digit is favored. With loss of a thumb distal to the base of the proximal phalanx, a digit other than the index, unless it is damaged, should be considered if any reconstruction is indicated. When a digit other than the index is transposed, the flexor profundus tendon must be divided proximally and the distal stump sutured to the proximal stump of the independent flexor pollicis longus. Ideal incisions for transfers were illustrated in slides.

In discussion, Dr. A. W. Farmer [49] stated that disability from loss of the thumb varies in individuals and some carry on with their livelihood without having reconstructive surgery. He has never transferred the little finger. Reconstruction of a new thumb is considered worthwhile but, compared with the normal, the reconstructed thumb always lacks something. Slides showed many different ways of handling the situation.

Wringer Injuries of the Hand. Dr. Vinton E. Siler [50] and Dr. Roy M. Iritani [51] reviewed and reported on the nature and extent of trauma and the resulting complications in 444 patients who had received washing-machine wringer injuries of the upper extremity during the past twenty years. They reviewed the literature and discussed the treatment of these patients. The occlusive compression dressing and the open method of treatment were compared. Except for the complicated cases, their patients were treated as out-patients at the Cincinnati General Hospital and followed closely in the Hand Clinic. About 67 per cent of the patients treated were under ten years of age. Their survey revealed no marked decrease in incidence of these injuries since introduction of the spin dryer. Forty-one of their 444 patients had wounds which required closure by skin grafts. Failure of the skin graft was noted in fifteen patients and a secondary grafting procedure was done when indicated. Of the 304 patients who could be followed, twenty-one patients had some residual limitation of motion in the extremity. Volkmann's ischemic contracture developed in two patients: the first had a fasciotomy and cervicothoracic sympathectomy with only slight return of function of the involved hand; the second, a six-year-old child, whose injury extended up to a point mid-way between the elbow and shoulder, was treated initially by elevation of the arm without a compression dressing. Skin slough and a mild degree of ischemia of the distal part of the arm developed but the extremity responded well to physical therapy and no residual impairment of function was noted when the child was last seen.

The authors reported 93.9 per cent excellent results, which compares favorably with reports by other investigators. In addition, only 9.2 per cent of the patients required skin-grafting and only 4.7 per cent had residual limitation of motion of the part. The employment of sound surgical principles makes it possible to treat the majority of patients suffering from wringer injuries to the upper extremity on an ambulatory basis. Hospitalization was reserved for the seriously injured patient and for those patients demonstrating complications requiring additional care.

Dr. Martin A. Entin [52] complimented the authors on their extensive follow-up of 320 cases in the past twenty years. In Dr. Entin's experience 75 per cent of his patients were hospitalized, but he pointed out that he might be seeing only the more involved cases. This discussor felt that the closed injury is the most treacherous one. When first seen this type of injury looks very insignificant; however, if one examines this hand four hours later, removing a carefully placed compression dressing from the extremity after it has been elevated during this time, one finds a hema-

48. 16 East 90th Street, New York 28, N. Y.
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50. Department of Surgery, Cincinnati General Hospital, Cincinnati 29, Ohio.
51. Cincinnati General Hospital, Cincinnati 29, Ohio.
52. 373 Medical Arts Building, Montreal, Quebec, Canada.

toma, since the dressing alone is unable to prevent oozing of blood under the skin. It has, therefore, been his policy in closed compression injuries to examine the extremities again four, twelve, and twenty hours later because unless this hematoma is evacuated by incision, the skin over it might be jeopardized.

With respect to the open wringer injury, Dr. Entin cautioned against resuturing the avulsed skin under tension since this injured skin does not tolerate such punishment. He felt that it is better to put the skin back in a relaxed position and cover the gap with a skin graft.

Dr. John P. Adams [53] felt that because of deep-seated hemorrhage and swelling of the muscles, an early sympathectomy might cause more fluid or blood loss into the extremity and thus be detrimental and hasten disaster. Immediate roentgenograms of the hand were unnecessary, as the incidence of fracture is low. The needed immediate application of a compression dressing from the finger tips to the axilla is more important than roentgenograms, which could be made at a later period.

Dr. Siler, in closing the discussion, stated that the medicolegal considerations force them to make immediate roentgenograms of the extremity and that with an emergency unit in operation they do not waste time.

An Experimental Evaluation of the Efficacy of Chymotrypsin in the Reduction of Edema in Crushed Extremities. Dr. Robert D. Allaben [54], Dr. Joseph L. Posch [55], and Dr. Robert D. Larsen [40] conducted controlled experiments on the crushed upper extremities of the rhesus monkey to determine the efficacy of chymotrypsin in controlling the resulting edema. Alternate animals were treated with chymotrypsin and the volumes of the extremities were determined by the water-displacement method. The results indicated that chymotrypsin is effective in reducing the edema of the crushed upper extremities of the monkey.

The dose required was ten times the proportionate dose for the human adult. Other workers have found this to be true in a variety of experimental animals. The reason for this dosage differential is not known but it may relate to greater inhibitory factors or other species differences present in the experimental animals.

From their studies, the authors felt that the first day's dosage is the most important. It definitely limited the degree of edema present on the second day. They are unable to state the number of days during which treatment should be continued since at ninety-six hours after crushing there was little significant difference between the arm volumes of animals treated only one day and the arm volumes of animals treated four days. Clinically, however, they seem to have had satisfactory results when the treatment was continued for four days. Because of the importance of the first day's dosage, they suspect that pretreatment with chymotrypsin would further limit edema. Experimental studies should be carried out to verify this assumption.

Dr. Erle E. Peacock, Jr., [16] complimented the authors on a well designed experiment. The mechanism of the reduction of edema intrigued Dr. Peacock. To the best of his knowledge it had never been demonstrated that the parenteral administration of an enzyme or enzyme precursor had increased the concentration of that enzyme or precursor in a selected target area. Increased fibrolytic activity following parenteral injection has been demonstrated, but it has never been possible to show an increase in the level of chymotrypsin in the area where the fibrolysis occurred. The increased fibrolytic activity might be mediated through another system such as the plasma-plasmin system which is triggered by the administration of chymotrypsin. It is known that the injection of endotoxins, trypsin, and other related substances, such as snake venom, causes an extreme release of histamine. Overdosages of chymotrypsin produced muscle relaxation, shock, and death, strongly suggesting that histamine may be released by the action of chymotrypsin. In view of this fact the discussor suggested that the authors repeat their experiment, using, instead of a monkey prototype, a histamine-depleted animal produced by the use of an experimental drug such as 48-A. He suggested that it also might be useful to repeat the experiment using a specific system such as the plasma-plasmin system with exact timing.

Dr. John L. Bell [19] stated that the evidence that this drug will decrease traumatic edema in human beings is still questionable.

Dr. Larsen, responding to a question concerning dosage by Dr. Bell, stated that they had used one cubic centimeter or 5000 units twice a day for four days; the drug was administered intramuscularly.

Gout in the Upper Extremity and Hand. Dr. Lee R. Straub [56], Dr. James W. Smith [57],

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54. Woman's Hospital, Detroit 1, Michigan.
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57. New York Hospital, New York 21, N. Y.

Dr. George K. Carpenter, Jr.[58], and Dr. George H. Deitz[59] reviewed the management of gout in the upper extremity in a series of patients followed over the past fifteen years at the Hospital for Special Surgery. The variance in the distribution and characteristics of large, disabling tophi at the elbows, wrists, and hands was outlined. The most typical site of primary occurrence was the dorsum of the second and third metacarpophalangeal joints with the tophaceous material encompassing the tendons, ligaments, and neurovascular structures. The invasion of bone was characteristic.

Despite better understanding of the manifestations of gout and their control, tophaceous gout with its crippling deformities was still seen. Recent experience would indicate that this is because about 5 per cent of the patients with gout cannot be controlled adequately by medical therapy alone. It is in this group that surgical assistance would seem most justified. For this purpose the surgical experience in twenty-one cases of tophaceous gout with involvement of the upper extremity was analyzed. Sixty-seven tophaceous deposits were removed from the upper extremities during thirty-six operative procedures. Of special interest were five patients in whom the urate deposits at the wrist level were found to involve the flexor tendons to the fingers. In one patient both sublimis and profundus tendons were infiltrated. In the remaining four, only involvement of the sublimis tendons was found. These tophi were always encapsulated and confined to the tendon substance. Although in several patients, continuity of the tendon had been largely destroyed, in none was a tendon rupture noted. In one of the five the tophaceous mass produced median-nerve compression. In the other four, the tophi caused flexion contractures in the fingers. The findings in this study suggest that when large deforming tophaceous masses exist, when function has been impaired, or when drainage and infection are present, surgery offers definite benefits. Complete removal of tophaceous material at the expense of function was not advisable.

Dr. Sam G. Stubbins[60] suggested that a high index of suspicion be maintained and that gout be considered as a diagnostic possibility when dealing with trigger-finger, ganglia of the wrist, and localized joint pains in the hand. Many of these patients with these symptoms responded beautifully to protozone therapy. He suggested a conservative try at drugs prior to final decision to intervene surgically.

Dr. George S. Phalen[61] cautioned against early excision of a tophus as a prophylactic measure to prevent joint or tendon damage and said this treatment is seldom if ever indicated because the uricosuric drugs now at our disposal do such an excellent job. Surgical treatment of gout to improve appearance only is often unsuccessful since incomplete removal of the tophus still leaves the finger with an abnormal contour. If the surgeon becomes too aggressive in his attempt to excise the tophus completely, the end result will be a finger that looks better but has poorer function. The tophus should not be removed completely if such a procedure entails the sacrifice of an essential structure. Amputation of a finger because of gouty involvement is seldom necessary since arterial circulation of a digit is not often impaired by the deposition of urates. When all the structures of the fingers are involved, however, and the useless finger is impeding function of the rest of the hand, amputation of the finger is justified.

When gout involves the hand, the systemic manifestations of the disease are quite obvious since the hand is involved late in the course of the disease.

Dr. Straub, in closing the discussion, mentioned the patients with uncontrollable gout, the profound form of the disease, who, despite a strict medical regimen and the administration of colchicine, have increasing acute manifestations of the disease. Although these patients were sometimes controlled by corticosteroids, they often continued to manufacture tophi. Other patients, under carefully controlled medical programs have shown, after follow-up of ten to twelve years, disappearance of tophi. The uric-acid level is not always a reliable indication and its interpretation may be very difficult.

Primary and Secondary Reconstruction of Finger-Tip Injuries. Dr. Richard I. Gonzalez[62] and Dr. Harry J. Buncke, Jr.[63], presented their experiences over the past three years with 346 primary and secondary soft-tissue finger reconstructions. They felt that maximum function could be preserved and the best appearance of the finger could be attained by wide excision of crushed or traumatized tissue and closure of defects by primary split-thickness skin grafts. Primary pedicle flaps were rarely indicated and they were used only when it was necessary to cover denuded cortical bone or joint surfaces; this need arose in only 1 per cent of fresh injuries. Their experience

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62. 104 St. Matthews Avenue, San Mateo, California.
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was in marked contrast to the recently published series by Brody and associates and by Kislov and Kelly; these authors had utilized primary flaps in 30 per cent of their freshly injured fingers. Dr. Gonzalez and Dr. Buncke felt that length of the finger, the nailbed, the nail root, bone, and tendon could be adequately preserved with minimum morbidity by using split-thickness skin grafts. Restoration of contour, if necessary, was best done as a secondary procedure utilizing thenar or hypothenar flaps; these flaps were thought to be particularly indicated in the reconstruction of finger tips and were considered superior because the return of sensation in the graft approximated normal finger-tip sensation, the color and texture of the graft matched the rest of the finger perfectly, and the donor site could be obliterated with minimum scarring. Cross-finger flaps should be reserved for the repair of defects in the proximal or middle segments of the finger since it is impossible to obliterate the donor-site deformity. This is one of the contra-indications to the use of these flaps. Secondary fingernail reconstruction had been disappointing. For this reason every effort should be made to preserve nail root or bed at the time of primary treatment.

Colored transparencies showed cases of ring injuries with avulsion or degloving of the finger. These injuries had been treated with primary split-thickness skin grafts and the results served to emphasize that these grafts take well on bare tendon, bone, and joints. Also shown were colored transparencies of a gangrenous thumb, the result of a crushing injury, which had been treated successfully with a single-stage abdominal flap.

Dr. Robert D. Larsen [40] cautioned against the use of the thenar and palmar flaps in middle-aged working men with stiff fingers. He had found this procedure to be disabling because of residual stiffness and contracture of finger joints, painful scars at the donor site, and, often, unsatisfactory padding on the recipient finger tip. He felt that their use should be restricted to carefully chosen cases.

a. Brody, G. S.; Cloutier, A. McL.; and Woolhouse, F. M.: The Finger Tip Injury—An Assessment of Management. Plast. and Reconstruct. Surg., **26**: 80–90, 1960.

b. Kislov, Richard, and Kelly, A. P., Jr.: Cross-Finger Flaps in Digital Injuries, with Notes on Kirschner Wire Fixation. Plast. and Reconstruct. Surg., **25**: 312–322, 1960.

News Notes

The Orthopaedic Research and Education Foundation announces the establishment of an Educational Fellowship to be taken under Dr. Lent Johnson at the Armed Forces Institute of Pathology. This Fellowship will extend through a period of six months and will cover the expenses at the Institute and a minimum of living expenses: for single candidates a stipend of $2,000 and for married candidates $3,000. Only those who intend to devote their careers to full-time teaching positions in orthopaedic surgery will be considered. Applications may be secured from the office of the Secretary, Dr. Harold A. Sofield, 29 East Madison Street, Chicago, Illinois.

Honorary Fellowship of the Royal College of Physicians and Surgeons of Canada was conferred on **Sir Walter Mercer,** Chairman of The British Editorial Board of The Journal of Bone and Joint Surgery, British Volume, on January 20, 1961. On January 24, Sir Walter delivered the first Alexander Gibson Memorial Lecture at the University of Manitoba, Winnipeg.

The Ohio Orthopaedic Society held its Annual Meeting in Springfield on April 14 and 15, 1961. The program was as follows:

Fractures and Dislocations of the Cervical Spine. Francis C. Link, M.D.;
Osteotomy of the First Metatarsal for the Correction of Metatarsus Primus Varus and Hallux Valgus. Clarence W. Hullinger, M.D.;
Hip Fractures Treated by Pugh Nails. John W. Elliott, M.D.;
Congenital Dislocation of Hips. R. Hugh Mabry, M.D.;
Arthrodesis of the Hip by Pin Fixation Only. Clarence W. Hullinger, M.D.;
Case Report. Richard Tapogna, M.D.

The next Annual meeting will be held in Columbus, Ohio, in conjunction with the Ohio State Medical Association Meeting.

The St. Louis Orthopedic Society held their biannual meeting on April 12, 1961, at the University Club in St. Louis, Missouri. Officers elected for the ensuing year were:

President: Ralph K. Earp, M.D.;
Vice-President: Villray Blair, M.D.;
Secretary-Treasurer: George Scheer, M.D.

The guest speaker was Dr. J. Robert Close, Oakland, California, who spoke on electromyography.

Part II Examinations, oral and written, of **The American Board of Orthopaedic Surgery** will be given in Chicago, Illinois, January 24, 25, and 26, 1962. The deadline for filing applications is July 1, 1961. Inquiries should be addressed to Dr. Sam W. Banks, *Secretary-Treasurer*, The American Board of Orthopaedic Surgery, 29 East Madison Street, Chicago 3, Illinois.

The Annual Meeting of the **Orthopaedic Guild** was held at the Jefferson School of Medicine, Philadelphia, Pennsylvania, November 3, 4, and 5, 1960, under the Chairmanship of Dr. Anthony F. DePalma. Officers elected for the ensuing year are:

Chairman: John Donaldson, Pittsburgh, Pennsylvania;
Secretary: K. Armand Fischer, M.D., Louisville, Kentucky.

The next Annual Meeting will be held in Pittsburgh, Pennsylvania.

CORRECTION

An error occurred in Dr. Chuinard's discussion of the paper by Dr. Sherman S. Coleman "Treatment of Congenital Dysplasia of the Hip and Its Sequelae" as abstracted in Proceedings of the Western Orthopedic Association, J. Bone and Joint Surg., **43-A**: 316, March 1961. The last sentence of the abstract of Dr. Chuinard's discussion should read "Subtrochanteric osteotomy has been helpful in creating anteversion and **correcting** coxa vara, which aids in maintaining reduction.

Book Reviews

THE PUBLICATED [sic] RESULTS OF THE DEPARTMENT OF ORTHOPEDIC SURGERY OF KYUSHU-UNIVERSITY DURING 50 YEARS. The Department of Orthopedic Surgery (*Director*, Prof. T. Amako), Kyushu-University, Fukuoka, Japan. Tokyo, Japan, Nanzando Co., Ltd., 1960.

It is the purpose of this volume to introduce to readers in countries outside Japan the achievement of The Department of Orthopedic Surgery of Kyushu-University. Résumés of 102 of the 528 contributions to the Japanese literature that have emanated from this department during its fifty years of existence are presented.

A foreword and progress report trace the development of the Department. Accompanying these are letters of congratulation from famous orthopaedic surgeons all over the world. This introductory section gives an interesting account of the development and progress of orthopaedic surgery in Japan during the last half-century.

The subject matter of the résumés presented covers a wide range of topics including the physiology, pathology, and chemistry of bone; osteogenesis; rickets and osteoporosis; fractures; the anatomy and physiology of joints and cartilage; bone and joint tuberculosis; and electromyography (to mention but a few).

From the summary of the first article "A Study of the Growth of the Epiphyseal Tubercle of Each Vertebral Body" to the final one, "Low-Back Pain Afflicting Coal Mine Workers" this volume presents a wealth of information. A clear indication is given of the extent of original research and the many contributions to orthopaedic surgery that have been made in Japan in the last fifty years.

Copies of this volume and the original articles may be obtained from Prof. Tamikazu Amako, Department of Orthopedic Surgery, Faculty of Medicine, Kyushu-University, Fukuoka, Japan.

David M. Bosworth, M.D.

CALCIFICATION IN BIOLOGICAL SYSTEMS. Edited by R. F. Sognnaes. Washington, D. C., American Association for the Advancement of Science, 1960. $9.75.

Few, if any, basic biological processes are of greater significance to orthopaedists than the fundamental phenomenon of mineralization. It lies at the heart of skeletal growth and development. It is critical to the successful management of every fracture, every osteotomy, every bone graft, and every arthrodesis.

In its abnormalities it plagues the orthopaedic surgeon in such forms as myositis ossificans in paraplegic patients; excessive bone formation, complicating arthroplasties; calcification of the ligaments of the spine in Marie-Strümpell disease; and calcific bursitis; not to mention the serious abnormal calcification that occurs in heart valves, great vessels, and the kidney.

A major contemporary investigative effort is being made to unravel the mysteries of this interesting and important facet of biology and medicine. For a group so directly concerned with calcification in their daily activity, orthopaedists, with a few salient exceptions, have contributed surprisingly little to this movement. The vast majority of orthopaedists have less than a passing acquaintance with the subject. Obviously, this must change, for it will be a major function of the orthopaedist, in the future, to apply intelligently the slowly evolving results of such research to the daily problem of patient care.

Calcification in Biological Systems is the publication of a recent symposium on this problem. The papers range from "Calcification in Unicellular Organisms" to "Specificity of the Molecular Structure of Organic Matrices in Mineralization". Authoritative current views are given on the nature of collagen, the structure of hydroxy apatite, the relationship between collagen and mineralization, calcification of cartilage, calcified dental tissues, experimental bone resorption, abnormal mineralization, crystal-collagen relationship in healing rickets, and many other related topics. Here, then, is a compilation of significant contemporary thought brought sharply to focus on the process and problems of mineralization.

The book is difficult reading for the uninitiated because of the wide range of investigative disciplines and techniques represented. The research methods and the experimental concepts expressed are, by and large, developments made long after most orthopaedists had any direct contact with basic science. Nonetheless, if orthopaedic surgeons are to move intelligently as orthopaedics develop they must, in the future, be cognizant of these impressive biological investigations; they would do well to start now with the reading of this book. The caliber of individual chapters shows considerable variations, as must be expected in any book with thirty-two authors.

William H. Harris, M.D.

Books Received

We acknowledge with thanks the receipt of the following books. Books that appear to be of particular interest to readers of *The Journal* will be reviewed as space allows.

Annals of the New York Academy of Sciences. Vol. **86,** Art 4: Connective Tissue and Diseases of Connective Tissue. $3.50. Vol. **88,** Art. 5: Biochemical Aspects of Microbial Pathogenicity. $5.00. Vol. **88,** Art. 1: The Reticuloendothelial System (Res.). $3.50. Vol. **90,** Art 3: Biochemistry and Pharmacology of Compounds Derived from Marine Organisms. $5.00. New York, Published by The Academy, 1960.

Atlas of Anatomy and Surgical Approaches in Orthopaedic Surgery—Lower Extremity. Rodolfo Cosentino, M.D. Preface by Carroll B. Larson, M.D. 8 vo. 264 pp. 139 plates. Springfield, Illinois, Charles C. Thomas, 1960. $14.00.

Calcium Metabolism and the Bone. Paul Fourman, M.D., D.Sc., F.R.C.P. 325 pp. Springfield, Illinois, Charles C. Thomas, 1960. $8.50.

Congenital Deformities. Gavin C. Gordon, M.B., F.R.C.S.E. 128 pp. 113 ill. Baltimore, The Williams and Wilkins Co., 1961. $8.50.

Disc Lesions and Other Intervertebral Derangements. Treated by Manipulation, Traction and Other Conservative Methods. E. J. Crisp, M.D., D.Phys. Med. 158 pp. 48 ill. Baltimore, The Williams and Wilkins Co., 1960. $3.75.

Electromyography in Nervous Diseases and in Cryptotetany. With Atlas. N. Rossele, K. de Doncker, P. Jolie, A. van Betsbrugge, and S. Ligot. English translation by Joseph B. Rogoff, M.D. 277 pp., 183 ill. Louvain, Éditions Nauwelaerts, 1960. 350 FB. (Text in English, French and German.)

Evaluation and Management of the Brain-Damaged Patient. Jerome S. Tobis, M.D., and Milton Lowenthal, M.D. 109 pp., 38 ill. Springfield, Illinois, Charles C. Thomas, 1960. $6.00.

Geschichte der Orthopädie. Prof. Dr. Bruno Valentin. 288 pp., 142 ill. Stuttgart Georg Thieme Verlag, 1961. $9.45. A History of Orthopaedics (German).

Key and Conwell's Management of Fractures, Dislocations and Sprains. H. Earle Conwell, M.D., F.A.C.S., and Fred C. Reynolds, M.D. Seventh Edition, 1153 pp., 1227 ill. St. Louis, The C. V. Mosby Co., 1961. $27.00.

Klinische Chirurgie für die Praxis. Edited by Prof. Dr. med. O. Diebold, Prof. Dr. med. H. Junghanns, and Prof. Dr. med. L. Zukschwerdt. Stuttgart, Georg Thieme Verlag. Vol. **I,** Pt. 3, 1960. $12.85: Vol. **I,** Pt. 4, 1961. $12.85: Vol. **II,** Pt. 1, 1960. $10.00: Vol. **III,** Pt. 1, 1960. $6.70: Vol. **III,** Pt. 2, 1960. $9.50: Vol. **III,** Pt. 3, 1961. $9.75 (in German).

Lumbar Discography and Low Back Pain. Donald deForest Bauer, M.D., C.M., M.Sc. 89 pp., 34 ill. Springfield, Illinois, Charles C. Thomas, 1960.

The Normal Skull: A Roentgen Study. Robert Shapiro, M.D., and Arnold H. Janzen, M.D. 257 pp., 645 ill. New York, Paul B. Hoeber, Inc., 1960. $18.00.

Orthopaedia. Nicolas Andry. (Facsimile reproduction of the First Edition in English, London, 1743.) 2 vols., 12 mo., boxed. Philadelphia, J. B. Lippincott Company, 1961. $10.00.

Orthopaedics. George Perkins, M.C., M.Ch., F.R.C.S. 975 pp., 577 ill., index. London, University of London, 1961. $29.00. In this general treatise the author sums up the deductions of a lifetime's work as a clinician and a teacher at St. Thomas's Hospital, London.

Outline of Fractures Including Joint Injuries. John Crawford Adams, M.D., F.R.C.S. Third Edition. 268 pp , 241 ill. Baltimore, The Williams and Wilkins Co., 1960. $6.50.

La Poliomielite: Diagnostica e Terapia dei Postumi. G. Botteri, A. Castellana, G. Corsi, G. Dadone, F. Franco, A. Fusari, G. Gila, and D. Logròscino. 697 pp., 335 ill., 77 in color. Napoli, V. Idelson di E. Gnocchi and F., 1960. L. 10,000 (in Italian).

The Surgery of Mitral Stenosis. Robert P. Glover, M.S. (Surg.), F.A.C.S., F.A.C.C., and Julio C. Davila, M.D., F.A.C.S., F.A.C.C. New York, Grune & Stratton, 1961. $9.50 (Modern Surgical Monographs).

Les Tractions Vertébrales. J. Levernieux. Preface by Professeur S. de Sèze. 124 pp., 35 ill. Paris, Expansion Scientifique Française, 1960 (in French).

The Transplantation of Tissues and Organs. Michael F. A. Woodruff, M.D., M.S., F.R.C.S., F.R.C.S.E., F.R.A.C.S. 777 pp., 196 ill., 110 pp. of references. Springfield, Illinois, Charles C. Thomas, 1960. $25.50.

Traumatic Lesions of Peripheral Vessels. Carl W. Hughes, A.B., M.D., and Warner F. Bowers, M.D., Ph.D. 197 pp., 58 ill. Springfield, Illinois, Charles C. Thomas, 1961. $8.00.

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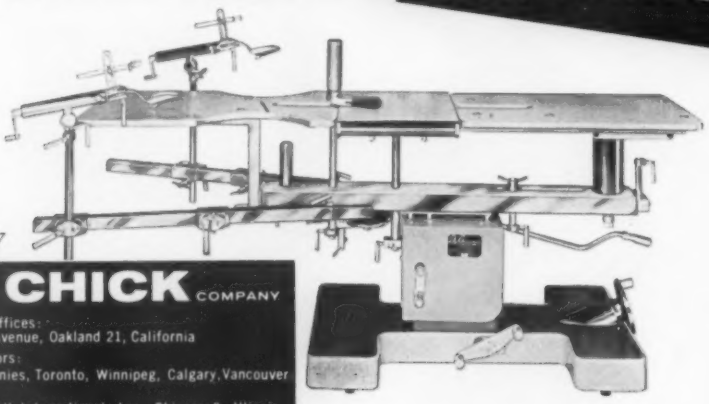

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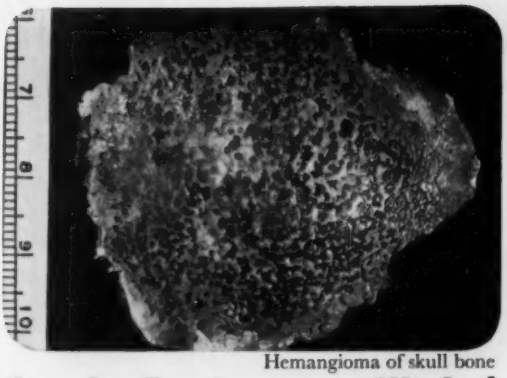

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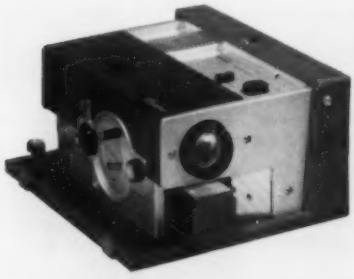

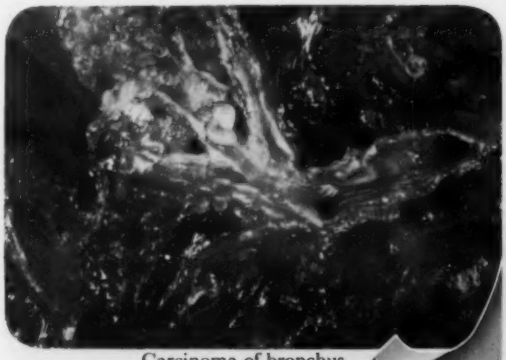

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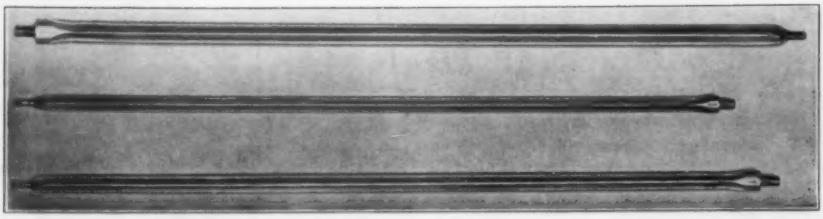

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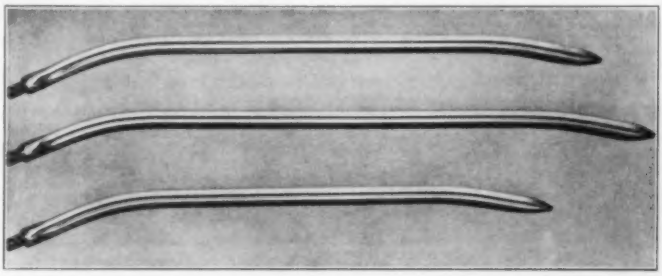

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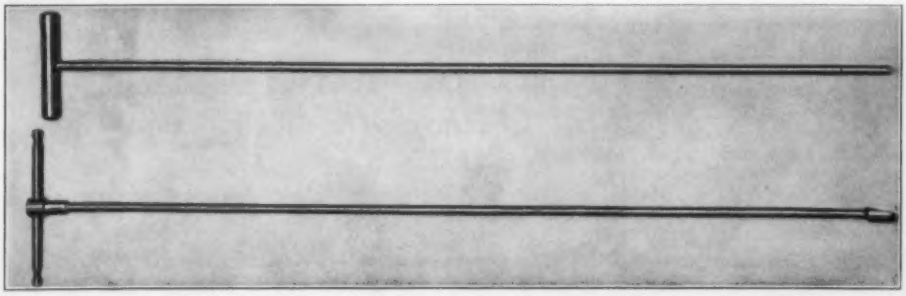

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